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Psychology

The Benefits of Nostalgia Within Spatial Environments for People With and Without Alzheimer's Disease

by

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<u>Abstract</u>

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Nostalgia, a sentimental longing for the past, is a mostly positive, social emotion. The regulatory model of nostalgia proposes that the emotion is triggered by adverse psychological and physical states. In turn, nostalgia counters those threatening states and facilitates psychological equanimity. My first objective was to extend this model to a new environmental threat; spatial anxiety, that is, apprehension and fear about environmental navigation. To date, there are no experimental inductions of spatial anxiety. In Chapter 2, I addressed this lacuna and developed a novel protocol for inducing spatial-anxiety within a virtual environment. Then, in Chapter 3, I tested the regulatory model of nostalgia in relation to spatial anxiety. In Experiment 3.1, I implemented the validated spatial-anxiety induction (developed in Chapter 2) and demonstrated its effect on nostalgia. Experiment 3.2 and 3.3 installed wall-mounted nostalgic (versus non-nostalgic) pictures within a virtual environment to assess its effect on spatial anxiety. Passive and active navigation of a nostalgic (versus non-nostalgic) environment reduced spatial anxiety. Nostalgia assuages spatial anxiety during navigation. As well as curtailing adverse conditions, nostalgia serves a number of psychological functions, including social connectedness, self-continuity, meaning in life, self-esteem, and positive affect. The second objective of this thesis was to investigate the potential benefits of nostalgia among a clinical population that experiences navigation difficulties in daily life. In Chapter 4, I further developed the pictorial nostalgia induction of Chapter 3 and implemented it among people living with Alzheimer's disease. In Experiment 4.1, I generated wall-mounted nostalgic (versus non-nostalgic) pictures associated with the decade during which middle-aged older adults lived most of their childhood. Then in Experiment 4.2, I interviewed people with Alzheimer's disease about fond memories from their past and selected personal images corresponding each event. Nostalgic (versus non-nostalgic) pictures boosted social connectedness, self-continuity, meaning in life, self-esteem, and positive (but not negative) affect. Among people with Alzheimer's disease, the nostalgic landmarks enhanced picture recognition (but not spatial memory). This work holds real-world applications, in particular, for dementia-friendly design.

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Chapter 1: General Literature Review

1.1 Introduction

Nostalgia, “a sentimental longing or wistful affection for the past” (*The New Oxford Dictionary of English*, 1998, p. 1266), is a predominately positive, past-orientated emotion (Sedikides & Wildschut, 2016). The regulatory model of nostalgia specifies that adverse events will negatively influence one’s current state, but will also trigger nostalgia. In turn, nostalgia will positively influence one’s current state. Ultimately, nostalgia maintains psychological balance by counteracting negative states. I begin this chapter by introducing nostalgia and its historical journey; from past misconceptions to present-day scientific research. I then discuss the triggers of nostalgia, and its psychological functions, followed by a review of nostalgia’s regulatory model. Next, I introduce spatial anxiety and outline key concepts within the navigation domain, as well as the virtual environment methodology I implemented in my research. Finally, I introduce the difficulties with navigation encountered by people living with Alzheimer’s disease (AD) and discuss how nostalgia may help to alleviate these.

1.2 Nostalgia

The term ‘nostalgia’ derives from the Greek words *nostos*, meaning return, and *algos*, meaning pain or suffering. The Swiss physician Johannes Hofer (1688/1934) coined the word to describe a set of adverse physical and psychological symptoms experienced by Swiss mercenaries serving away from home. Among the displaced soldiers, Hofer witnessed bouts of weeping, persistent thinking of home, insomnia, stomach pain, and loss of appetite (McCann, 1941). Such observations led Hofer to conceptualise nostalgia as a neurological disease.

Long before Hofer established the term, the origin of nostalgia is a poetic one. In Homer’s classical epic, *The Odyssey,* the hero Odysseus begins an arduous trek home to Ithaca after fighting in the Trojan War. Whilst on his journey, Odysseus reflects on memories of loved ones and longs to return to his wife, Penelope. The notion of nostalgia originated from this unique human ability to immerse oneself in memories of the past in order to gather internal strength and motivation. However, in the years that followed, nostalgia's poetic roots became distorted. In the early 19th century, definitions of nostalgia shifted from a neurological disease to a psychological disorder that comprised melancholia and depression (Rosen, 1975; McCann, 1941). Psychodynamic theorists and clinicians also linked nostalgia to mourning, depression, and psychosis (Castelnuovo-Tedesco, 1980; Frost, 1938; Sterba, 1940). For centuries, the term was used as a medical diagnosis—an outlook partly explained by the fact that "nostalgia" and "homesickness" were often used synonymously (McCann, 1941).

Positive connotations of nostalgia re-emerged in the 1950s. Martin (1954, p. 103) viewed it as a "diastolic phase of the growth rhythm," playing a role in recuperation and phases of development. Davis (1977, p. 418) was the first researcher to describe nostalgia as a feeling "infused with sentiments of past beauty, pleasure, joy, satisfaction, goodness, happiness." His research showed that "nostalgia" and "homesickness," in fact, hold independent meanings (Davis, 1979). College students identified words such as "warm," "childhood," and "old times" more with nostalgia than with homesickness. It would take until the turn of the 20th century for psychological research to restore perceptions of this fundamental emotion.

Today, nostalgia is defined by "a sentimental longing or wistful affection for the past" (*The New Oxford Dictionary of English*, 1998, p. 1266). The layperson's view of nostalgia aligns with this definition. Hepper and colleagues (2012) systematically investigated lay conceptions of nostalgia among UK and US citizens using a prototype approach. In Studies 1 and 2, participants listed all the descriptors that, in their opinion, best described nostalgia. Two authors then independently coded 1,752 descriptors into 35 features. Then, participants rated the centrality of each feature according to their view of nostalgia. In line with past prototype research (Gregg et al., 2008, Kearns & Fincham, 2004), a median split divided 18 of the most highly rated features as central (i.e., more salient) to nostalgia and 17 of the lowest rated features as peripheral (i.e., radial) to nostalgia. Central features included fond and meaningful past memories, often with loves ones and during one's childhood/youth. Objects such as memorabilia/keepsakes and sensory cues also featured prominently. Generally, memories were positive but also related to experiences that people long for, miss, and want to relive. Peripheral features included words such as warmth, daydreaming, change, ageing, regret, and sadness. Hepper et al. (2012) further validated the centrality (vs. peripherality) of nostalgia's features in Study 3. Participants read a series of statements that either had embedded within them a central (e.g., "Nostalgia is about childhood") or peripheral (e.g., "Nostalgia feels calm") feature. Next, participants completed recall and recognition tasks, in which central features were more freely recalled and falsely recognised than peripheral ones. In Study 4, participants viewed central, peripheral, and control (i.e., nostalgia-free) features on a computer screen. The computer task asked participants to answer 'Yes' or 'No' as quickly as possible to the question, "Is this a feature of nostalgia?". Participants judged central features as belonging to nostalgia both more frequently and quickly compared to peripheral or control features. Study 5 presented a new sample of participants with vignettes illustrating a character's autobiographical event. The vignettes contained either central, peripheral, or no features of nostalgia. Events with central features (relative to peripheral or no features) were rated by participants as significantly more nostalgic. Lastly, in Study 6, participants brought to mind a nostalgic or ordinary life event and rated it using the 35 prototypical features of nostalgia (e.g., central: "This event is a fond memory"; peripheral: "When I think about this event I feel regret"). Participants felt that nostalgic (vs. ordinary) events were characterised better by central features than by peripheral ones. In more recent years, Hepper et al. (2014) found that lay conceptions of nostalgia are shared across 18 countries (e.g., Australia, Chile, China, Ethiopia, Germany, India, Japan) on five continents. This prototypic view of nostalgia is endorsed by people of all ages (Hepper et al., 2021; Madoglou et al., 2017). Laypeople, across the globe, agree that nostalgia is a mostly positive, social, and past-orientated emotion.

The prototypic view of nostalgia is also supported by content analyses. Wildschut and colleagues (2006, Study 1) studied the content of memoirs published in the periodical *Nostalgia*. Narratives often featured the protagonist being surrounded by important others (e.g., family, friends, romantic partner). Nostalgia focused around momentous life events (e.g., holidays, weddings, birth of a child, sporting achievements), animals, tangibles (e.g., cars, coat, watches), and places (e.g., mountains, lakes, sunsets). Although most accounts contained both negative and positive feelings, they typically began with a negative feeling, which then progressed onto a predominantly positive event (Wildschut et al., 2006, Study 2). In other words, nostalgic narratives present a redemptive sequence, in which a negative scene redeems itself by a subsequent triumph or success.

Stephan et al., (2012) conducted further narrative analysis among UK undergraduate students. Across two experiments, narrative coding distinguished abstract versus concrete terms from nostalgic experiences and applied classification techniques including the Linguistic Category Model (Coenen et al., 2006) and the Linguistic Inquiry and Word Count software program (Pennebaker et al., 2007). The Linguistic Category Model comprised four categories of increasing abstractness (i.e., descriptive action verbs, interpretive action verbs, state verbs, and adjectives). The Linguistic Inquiry and Word Count Program measured the presence of cognitive processes within each narrative. More specifically, words associated with causation or insight inferred a higher level of abstraction. In Experiment 1, written accounts of nostalgia presented a greater number of abstract linguistic terms in comparison with ordinary accounts. No differences between nostalgic and ordinary accounts emerged in the use of concrete linguistic terms. However, further statistical analysis identified that nostalgic (relative to ordinary) accounts present more concrete terms that describe the relevance of the past with the present. Experiment 2 replicated these findings and introduced positive accounts alongside nostalgic and ordinary ones. Again, nostalgic experiences entailed more abstract and concrete terms, but the latter result only emerged when concrete terms connected the past to the present.

Nostalgia is characterized by ambivalent, but predominately positive feelings. In Werman's (1977) words, the emotion encompasses "joy tinged with sadness" (p. 393). A recent meta-analysis examined 41 peer-reviewed studies that experimentally manipulated nostalgia (Leunissen et al., 2021). Across these experiments, participants in the nostalgia condition felt significantly more positive than negative affect (a *positivity offset*; Cacioppo & Berntson, 1994). Overall, inductions of nostalgia increased positive and ambivalent (but not negative) affect. Nostalgic experiences in daily life align with this positivity offset, in a 1-week daily diary study (Newman et al., 2020; Study 5), university students rated their everyday nostalgic experience on a 7-point scale and reported considerably higher positivity ($M = 5.02$) than negativity ($M = 2.47$). Turner and Stanley (2021) assessed everyday nostalgia further by examining the daily experiences among young, middle-aged, and older adults. Individuals across the lifespan rated their nostalgic experiences more positively than negatively (J. R. Turner, personal communication, August 9, 2022; see also Thibault, 2016). In all, nostalgia engenders considerably more positive than negative affect.

Additional empirical research has delineated nostalgia by comparing and contrasting it with other emotions. Van Tilburg et al. (2018) compared nostalgia to 10 other self-relevant emotions, including embarrassment, gratitude, guilt, hurt, feelings, inspiration, passion, pride, shame, and unrequited love. Across four studies, 169 University students rated the similarity (versus difference) for 55 emotion pairs (e.g., nostalgia-shame, inspiration-pride, unrequited love-nostalgia). The ratings generated a participant-specific, "similarity matrix," which were then analysed using multidimensional scaling (Kruskal & Wish, 1978). Multidimensional scaling analyses present a visual representation of the similarities and/or differences between constructs (e.g., emotions). In this dimensional model, constructs that differ are positioned further apart and constructs that are similar are positioned closer together. Nostalgia related to emotions such as self-compassion, pride, and gratitude but differed from emotions such as shame, embarrassment, and guilt. Nostalgia was high in pleasantness (i.e., valence) and approach orientation, yet featured relatively low in arousal. These findings were replicated in a subsequent online study (Van Tilburg et al., 2018, Study 5). The appraisal profile of nostalgia illustrates that, in relation to 10 other emotions, nostalgia is uniquely characterized by distant events, which are pleasant but irretrievable (Van Tilburg et al., 2019).

1.3 Triggers of Nostalgia

Various stimuli are known to elicit nostalgia, and these are broadly categorised into external or environmental triggers and internal or subjective triggers. External triggers are sensory, including music (Barrett et al., 2010), song lyrics (Cheung et al., 2013), smells (Reid et al., 2015), tastes (Supski, 2013), objects and events experienced in childhood (Holbrook & Schindler 1996), and adverse climatic conditions (Van Tilburg et al., 2018; Zhou et al., 2012). Internal triggers are interwoven with negative affect, including negative mood (Wildschut et al., 2006), life meaninglessness (Routledge et al., 2011), existential angst (Routledge et al., 2008), self-discontinuity (Sedikides et al., 2015), loneliness (Wildschut et al., 2006), anticipated social exclusion (Seehusen et al., 2013), relationship pessimism (Abeyta et al., 2015a), and boredom (Van Tilburg et al., 2013). Next, I focus on nostalgia's most potent triggers.

Early on, Davis (1979) theorized that nostalgia "occurs in the context of present fears, discontents, anxieties, and uncertainties" (p. 34). Studies since have shown that negative affect is the most common trigger of nostalgia. Wildschut et al., (2006, Study 2) examined the content of nostalgic narratives by instructing British university students to write about the circumstances under which they wax nostalgia (e.g., “When do you bring to mind nostalgic experiences?” “What seems to trigger your memory of the nostalgic experiences?”). 38% of written responses reported negative affective states as typical triggers. These accounts were categorized into discrete negative affective states (e.g., feeling “lonely”, “scared”) and generalized affective states (e.g., feeling “sad” or “depressed”). Some participants expressed a combination of discrete and generalized affective states, thus, each subcategory was not mutually exclusive.

Wildschut et al., (2006, Study 3) investigated this further by experimentally manipulating negative mood—a generalized negative affective state. Participants read a news story that differed in terms of positive, negative, or neutral content. In the positive mood condition, participants received an uplifting story about the birth of a polar bear. In the negative mood condition, participants read about the tsunami that hit coastal regions in Asia and Africa. In the neutral mood condition, participants read about the landing of the Huygens probe on Saturn’s moon, Titan. Participants then completed a (successful) manipulation check and Batcho’s (1995) Nostalgia Inventory (NI), which measured how nostalgic they felt about 18 aspects of their past (e.g., “my family”, “the things I did,”). In comparison to the positive and neutral mood conditions, participants felt more nostalgic in the negative mood condition. Negative mood triggered nostalgia.

With regards to discrete negative affective states, 59% of nostalgic narratives touched on loneliness, making it the most frequently reported discrete affective trigger of nostalgia. Loneliness is a discomforting state characterized by a lack of social support, for instance, a person typically perceives having fewer and less satisfying relationships than desired (Cacioppo & Cacioppo, 2012). Wildschut et al., (2006, Study 4) tested whether experimentally induced loneliness (via false feedback) would increase nostalgia. British university students were given false feedback after completing 15-items from the UCLA

Loneliness Scale (Russell, 1996), which recorded their supposed degree of loneliness. In the high-loneliness condition, participants read items designed to encourage agreement with each statement using the prefacing word, 'sometimes' (e.g., "I sometimes feel isolated from others."). In the low-loneliness condition, participants read items designed to encourage disagreement with each statement using the prefacing word, 'always' (e.g., 'I always feel isolated from others.'). Immediately after, participants in the high-loneliness condition received feedback that they fell in the 62nd percentile of the loneliness distribution and were therefore "above average on loneliness." Participants in the low loneliness condition received feedback that they fell in the 12th percentile of the loneliness distribution and were therefore "very low on loneliness." To strengthen the manipulation, participants provided reasons for their alleged loneliness rating. Finally, participants completed Batcho's (1995) NI to assess how nostalgic they felt for 18 aspects of their past. High-loneliness participants felt more nostalgic than low-loneliness participants. Loneliness triggered nostalgia.

1.3 Functions of Nostalgia

Adverse states, such as negative affect and loneliness, trigger nostalgia. But what does nostalgia then do for the individual? Thus far, social psychologists have researched the functions of nostalgia in controlled laboratory settings. Most studies administer the Event Reflection Task (ERT; Wildschut et al., 2006). In this task, the experimenter randomly assigns participants to reflect on either a personal nostalgic event (nostalgia condition) or an everyday ordinary event (control condition). In some studies, alternative control conditions have involved recall of a positive past- or future-oriented event. After immersing oneself in the randomly assigned event, participants write a brief (i.e., 5 minute) summary about it and list associated keywords. Following a manipulation check, participants then complete a series of relevant outcome measures, which usually fall into one or more of the posited psychological functions of nostalgia.

Generally, nostalgia facilitates better psychological health and wellbeing (Hepper et al., 2021; Kelley et al., 2022; Routledge et al., 2013; Sedikides et al., 2015). Nostalgia enhances social relationships (e.g., via increased support seeking and perceived support capacity; Batcho, 2013, Wildschut et al., 2010), strengthens subjective wellbeing (Cox et al., 2015; Zhou et al., 2022), boosts subjective vitality (e.g., via increased social connectedness and self-continuity; Sedikides et al., 2016; Wulf et al., 2020), raises competence (Weinstein et al., 2013; Wulf et al., 2020), increases autonomy (Weinstein et al., 2022), elevates optimism (Cheung et al., 2013; Evans et al., 2021)—all of which are core ingredients for psychological wellbeing (Su et al., 2014). On the next section I focus on the core functions addressed in my work.

1.3.1 Positive Affect

As previously discussed, nostalgia entails more positive than negative affect. Wildschut et al. (2006, Study 5), for example, administered the ERT and then measured state affect using the Positive and Negative Affect Schedule (Watson et al., 1988), which included items such as “happy,” “content,” “sad,” and “blue.” Participants who recalled a nostalgic (versus ordinary) past event reported greater positive affect, but not reduced negative affect. Stephan et al., (2012, Experiment 2) further examined affective states following a nostalgic versus ordinary autobiographical event using two positive (i.e., “makes me feel happy,” “puts me in a good mood”) and two negative (i.e., “makes me feel sad,” “makes me feel unhappy”) affect items (Wildschut et al., 2010). Again, participants felt more positive than negative affect.

1.3.2 Self-Esteem

Davis (1979, p. 41) documented in *Yearning for Yesteryear* that nostalgia “bestow[s] an endearing luster on past selves that may not have seemed all that lustrous at the time.” This influential statement indicated that nostalgia has the potential to augment one’s self-esteem. Wildschut et al. (2006) recorded self-esteem following the ERT, with a two item scale (“significant,” “high self-esteem;” Study 5) and Rosenberg’s (1965) Self-Esteem Scale (Study 6). Participants in the nostalgia (versus control) condition evinced higher levels of self-esteem. Hepper et al. (2012, Study 7) replicated this finding, but did so using a prototype induction of nostalgia. Specifically, participants viewed a list of features that were either central (nostalgia condition) or peripheral (control condition) to the nostalgia prototype. Participants then recalled a personal event that related to several features on their list and then reported their self-esteem levels (e.g., “I have many positive qualities,” “I feel good about myself”). In the nostalgia condition (central features), participants reported higher self-esteem compared to those in the control condition (peripheral features). In another empirical paper, Cheung et al. (2013) focused on music-evoked nostalgia. Participants who listened to a nostalgic (versus a cheerful, non-nostalgic) song reported higher self-esteem (Study 3). Nostalgia boosts self-esteem.

1.3.3 Self-Continuity

Davis (1979) further speculated that nostalgia is designed to remedy discontinuity between the past and present self “by marshalling our psychological resources for continuity” (p. 34). Accumulating evidence supports this claim. Sedikides et al. (2015, Study 3) successfully induced nostalgia via the ERT and then measured self-continuity using the Self-Continuity Index (e.g., “I feel connected with my past,” “Important aspects of my personality remain the same across time;” Sedikides et al., 2015). Participants who reflected on a nostalgic (versus ordinary) event reported higher self-continuity. In a following study, Sedikides et al. (2015, Study 4) instructed participants to recall a positive, as well as a nostalgic or ordinary autobiographical event. In comparison to both control conditions, nostalgia elevated self-continuity, and did so above and beyond positive affect. Alternative induction techniques such as scent-evoked (Reid et al., 2014) and music-evoked nostalgia (Sedikides et al., 2016) have also elevated continuity between the past and present self. Thus, nostalgia instils continuity in one’s life.

1.3.4 Social Connectedness

Written accounts of nostalgia frequently feature social themes and typically involve the self in the company of close others (e.g., family, friends; Wildschut et al., 2006, Studies 1-2). This led scholars to test whether nostalgic reverie can re-establish social connectedness. Wildschut et al., (2006, Study 5) instructed participants to think about a nostalgic (versus ordinary) event and recorded their perceptions of social bonds (e.g., feeling "loved" and "protected"). They found that nostalgia increased social connectedness. In a related study, participants who brought to mind a past event characterized by central (versus peripheral) features of nostalgia felt more loved, protected, and connected to loved ones (Hepper et al., 2012, Study 7). Moreover, participants who either thought about nostalgic (versus non-nostalgic) scents (Reid et al., 2014) or read nostalgic (versus non-nostalgic) song lyrics (Stephan et al., 2015) felt more socially connected. Taken together, nostalgia promotes a sense of social connectedness.

1.3.5 Meaning in Life

Nostalgia is sourced from momentous occasions from one's past (Abeyta et al., 2015b; Wildschut et al., 2006). In moments of nostalgic reflection, personal events may provide meaning in one's life (i.e., life is purposeful and significant; Arndt et al., 2013). A number of studies have tested this idea. Routledge et al., (2011, Study 2) induced nostalgia with song lyrics and then recorded meaning using a state version of the Presence of Meaning in Life subscale (e.g., "I have a good sense of what makes my life meaningful."), part of the Meaning in Life Questionnaire (Steger et al., 2006). Participants who read personally nostalgic (versus non-nostalgic) lyrics reported higher meaning in their lives. Hepper et al. (2012, Study 7) expanded on this and manipulated nostalgia via the prototype approach. After recalling an event that contained either central or peripheral features of nostalgia, participants completed a state-level measure of meaning (e.g., "life is worth living" "there is a greater purpose to life"). Those who recalled an event characterized by central (versus peripheral) features reported greater meaning. In another study, Van Tilburg et al. (2013, Study 5) administered the original ERT and found that nostalgic (versus ordinary) event reflection increased meaning in life. In a variant of the ERT, Routledge et al. (2012, Experiment 1), introduced a more rigorous control condition, which involved bringing to mind a desired future event. However, those who reflected on a nostalgic event still evinced a greater sense of meaning even compared to the imagined future event. In sum, nostalgia imbues life with meaning.

In all, research has documented that nostalgia serves a number of beneficial psychological functions. Nostalgia raises positive affect, boosts self-esteem, augments self-continuity, enhances social connectedness, and instils meaning in one's life.

1.4 The Regulatory Model of Nostalgia

So far, I have presented literature on two distinct pathways in the regulatory model. The first pathway connects discomforting states, such as negative mood and loneliness, to nostalgia. The second pathway connects nostalgia to restorative psychological functions, including positive affect, self-esteem, self-continuity, social connectedness, and meaning in life. The basis of this model evolved from research identifying the vital role of positive emotions in the regulation of psychological distress and maintenance of psychological or physiological homeostasis (Aspinwall, 1998; Folkman & Moskowitz, 2000). Levenson (1988, p. 25) proposed that positive emotions function as "undoers" of the physiological arousal induced by negative emotions. According to the undoing hypothesis, positive emotions present a restorative function that assists the body in maintaining a neutral "psychological homeostasis" (Fredrickson & Levenson, 1998). Based on this theory and growing empirical evidence, Sedikides et al. (2015) proposed that adverse negative states would serve as a trigger of nostalgia, which, in turn, nostalgia would alleviate. The core principle is that threatening states spark restorative defence mechanisms. This principle not only underpins the regulatory model of nostalgia, but also other theoretical frameworks such as attachment theory (Shaver & Mikulincer, 2008), self-affirmation theory (Steele, 1988), the after-effects of self-control on reward responsivity (Kelley et al., 2019), opponent-process theory of motivation (Solomon, 1980), the mnemic neglect model (Sedikides et al., 2016), and terror management theory (Pyszczynski et al., 2004). Next, I review a wide range of studies that simultaneously examine each pathway and provide support for the full regulatory model of nostalgia.

Zhou et al. (2008) conceptualized nostalgia as a coping mechanism that counteracts loneliness via perceived social support. In a sample of migrant Chinese children and teenagers, lonely participants felt that they received low social support but they also reported higher nostalgia. Nostalgia, in turn, enhanced their perceived social support (Study 1). The researchers next adopted an experimental approach and assessed nostalgia alongside perceived social support, after inducing loneliness (Study 2). Results consolidated the findings from the previous study, as participants exposed to the loneliness manipulation (vs. control) felt lonelier and perceived lower social support, but also felt more nostalgic. Nostalgia, in turn, was associated with higher perceived social support. Finally, Zhou et al. manipulated nostalgia using the ERT (Wildschut et al., 2006), and after recalling either a nostalgic or ordinary past event, participants rated their social support. As expected, nostalgia boosted perceived social support (Study 3). Taken together, this is evidence for how a negative psychological threat (i.e., loneliness) triggers nostalgia, and how nostalgia alleviated the threat (i.e., by increasing perceived social support).

Zhou et al. (2012) were the first to establish that nostalgia is a source for both psychological and physiological comfort in cold climatic conditions. In a longitudinal study, nostalgic engagement was more prominent on cold (vs. warm) days. The study that followed cemented this finding by experimentally manipulating ambient room temperature (cool = 20 °C; comfortable = 24 °C; warm = 28 °C). Participants in an artificially cooled room reported elevated feelings of nostalgia compared with the remaining temperate conditions. In addition, participants who were immersed in nostalgic (compared to ordinary) recollection (via ERT) also endured prolonged exposure to cold water in a subsequent cold pressor test. These results support nostalgia's ability to curtail thermoregulatory discomfort.

Van Tilburg et al. (2018) diversified the evidence base by including discomforting environmental triggers. Four studies investigated the association between weather adversity, distress, and nostalgia. Participants who listened to audio recordings of wind, thunder, and rain reported greater nostalgia compared to the control condition (i.e., audio recording of a quiet parking lot); adverse weather triggered nostalgia. Study 2 observed the effect of daily weather conditions on levels of distress and nostalgia over a 10-day period. Daily distress predicted greater feelings of nostalgia, especially in response to perceived wind. In a subsequent study, the authors assessed whether preventing nostalgic recollection would exacerbate weather-induced distress when listening to a wind (vs. control) recording. To test for this, half the participants completed a cognitive load task (e.g., counting backwards; Wegner, 1994) and the other half did not complete a cognitive load task. If cognitive load interferes with or prevents nostalgia, then the effect of adverse weather on distress should be stronger when cognitive load is present than absent. Indeed, results demonstrated that recordings of adverse weather increased distress more when cognitive load was present than absent, supporting the notion that nostalgia alleviates distress induced by adverse weather. In all, participants experienced nostalgia in response to adverse weather, but in turn, nostalgia curtailed weather-related distress. Nostalgia can be recruited as a regulatory tool to help cope with adverse weather.

1.5 Current Objectives

In sum, a substantial evidence base supports the full regulatory model of nostalgia and does so across diverse contexts. Nostalgia serves as a homeostatic corrective that combats distress and facilitates psychological equanimity. Considering nostalgia's restorative capabilities, I set out to test its role in countering a discomforting state specific to the spatial domain, that is, spatial anxiety (Lawton, 1994). My first objective, then, was to test the regulatory model of nostalgia in relation to spatial anxiety. Given that adverse conditions serve as a trigger of nostalgia, I tested the first part of the regulatory model by examining whether spatial anxiety would increase nostalgia. To do this, in Chapter 2, I first developed a novel experimental manipulation of spatial anxiety within a virtual environment. I then implemented this spatial-anxiety manipulation in Chapter 3 to assess its effect on nostalgia, testing the first part of the regulatory model (i.e., spatial anxiety to increased nostalgia). Next, also in Chapter 3, I tested the second part of the regulatory model by examining whether nostalgia, induced with wall-mounted pictures, would reduce spatial anxiety within a virtual spatial environment (i.e., nostalgia to reduced spatial anxiety).

My second objective was to investigate the psychological benefits of nostalgia, when induced in a spatial environment, for a relevant clinical population. Deficits in spatial navigation are one of the earliest indicators of pathological ageing (Lester et al., 2017) and dementia syndromes (e.g., AD) (Lithfous et al., 2013). In Chapter 4, I further developed the pictorial nostalgia manipulation introduced in Chapter 3. I did so initially among healthy middle aged-older adults. Next, I implemented a personalised, idiographic nostalgia induction among people with AD. I examined whether nostalgic (versus non-nostalgic) pictures would raise psychological functions among older people with and without AD, including social connectedness, self-continuity, meaning in life, self-esteem, and positive affect. To set the stage, I review the concept of spatial anxiety next.

1.6 Spatial Anxiety

In the present context, the term *spatial* refers to the environment humans navigate in waking life. *Navigation* is a “coordinated and goal-directed movement through the environment” (Montello, 2005, p. 257). It is a complex multisensory skill, which requires processing and utilising internal (e.g., somatosensory, proprioceptive) and external (e.g., visual and auditory) representations of one's environment (Arleo & Gerstner, 2000; Golledge, 1999; Gramann et al., 2006). Successful navigation allows people to reach desired places, to source food, socialise and travel; it facilitates a sense of well-being and emotional security (Lynch, 1960).

Montello (2005) proposed that navigation comprises two key components: locomotion and wayfinding. *Locomotion* or movement is guided by sensory and motor input that provides information about our immediate surroundings to coordinate movement, such as surfaces that are safe to travel on, or obstacles that must be avoided. *Wayfinding* is a motivated activity that directs movement and requires a plan to reach a desired goal. The navigator must efficiently link together path segments, including turn angles, segment lengths, and directions of movement. Repeated exposure to the calculated route helps the navigator remember and recall the journey for future use (i.e., *route-learning*; Golledge, 1999). Route-learning is typically conceptualised using Siegel and White's (1975) developmental theory of spatial learning. The authors constructed a framework that outlines the development of spatial knowledge in large-scale environments. First, the navigator must recognise landmarks and, then, devise a route that connects a sequence of landmarks. Over time, the navigator develops a configurational or network-like representation of the environment.

It has been proposed that humans rely on, and can simultaneously use, two key spatial reference frames (Chen, 2014). An egocentric reference frame consists of self-centred navigation. The navigator encodes spatial information from their perspective, for example, they learn to associate a particular landmark (e.g., church, post office) with a response (e.g., left or right turn). A landmark is defined as a salient environmental cue that functions as a distinctive point of reference during navigation (Nico et al., 2008). Landmarks are informative visual anchors that help a navigator formulate internal representations of surrounding environments (Denis et al., 2014). In an allocentric reference frame, the navigator views the environment from a survey perspective and develops a “cognitive map” (O’Keefe & Nadel, 1978; Tolman, 1948). This type of mental image utilises the position of landmarks relative to other landmarks, including estimations of distance and orientation (e.g., the church is 1 mile southeast of the post office).

In some instances, a navigator can lose their bearings. If this occurs, even momentarily, it can trigger a state of distress, anxiety, and frustration. Spatial disorientation has negative practical and emotional repercussions (Lynch, 1960), disorienting episodes can undermine one’s confidence in their spatial ability, resulting in feelings of apprehension and fear about environmental navigation (Lawton, 1994), also known as spatial anxiety. Lawton (1996) proposed that elevated spatial anxiety consumes cognitive resources, adversely impacting a navigators’ ability to attend to features in the environment, further increasing the likelihood of instances where a navigator may become lost.

Spatial anxiety is a domain-specific construct or “surface” trait that is most widely measured by the self-report Spatial Anxiety Scale (Lawton, 1994, 1996, Lawton & Kallai, 2002). The scale lists a number of scenarios related to everyday navigation that may trigger anxiety (e.g., “Finding your way back to a familiar area after realizing you have made a wrong turn and become lost while traveling” or “Leaving a store that you have been to for the first time and deciding which way to turn to get to a destination”), which participants then rate on a 5-point scale. Spatial anxiety is a key individual-difference characteristic that influences navigation. Generally, people who report higher levels of spatial anxiety are less efficient navigators. Hund and Minarik (2006), for example, devised a navigation task within a model town and measured spatial anxiety using Lawton’s (1994) Spatial Anxiety Scale. In the task, participants followed six different routes through the town using either landmark (e.g., “Turn toward the church on Memory Lane”) or cardinal directions (e.g., "Go north on Lemon Avenue"). Participants with greater self-reported spatial anxiety made significantly more navigational errors during the task (e.g., making a wrong turn, heading down the wrong street). In more recent study, Walkowiak et al. (2015) measured spatial anxiety (Lawton & Kallai, 2002) and asked participants to complete a route-learning task within a virtual 3D environment. In the learning phase of the task, participants followed a route through a virtual maze from a starting point to an end destination. The route presented directional arrows and contained seven local landmarks to aid navigation. In the testing phase, the arrows were removed and participants had to navigate back to the starting point using the same path in the learning phase. Participants who reported higher levels of spatial anxiety were significantly slower at completing the task, travelled longer distances, and made more errors along the route compared to those who reported lower spatial anxiety. Taken together, spatial anxiety negatively correlates with navigation performance. Studies thus far have been limited by correlational designs and, hence, the direction of causality between poorer navigation ability and higher spatial anxiety is still unclear (Weisberg & Newcombe, 2018).

Spatial anxiety is related yet distinct from other types of anxiety such as, general and mathematics anxiety (Alvarez-Vargas et al., 2020; Malanchini et al., 2017; McKheen, 2011). General anxiety is regarded domain-general or as a "personality" trait. General anxiety is associated with neuroticism, which denotes negative affectivity and vulnerability to stress (Cox et al., 1999). Similar to spatial anxiety, mathematics anxiety is domain-specific and denotes the negative emotional reactions towards mathematics or at the prospect of completing a mathematics-related task (Maloney et al., 2012). Although domain-specific and domain-general anxiety constructs moderately correlate (r = 0.24-0.44), each construct is largely independent. In a behavioural genetics study involving 1,464 19-21 year old twin pairs, Malanchini and colleagues (2017) examined the factor structure of anxiety. In total, 26-items measured general anxiety (using the 7-item

Generalized Anxiety Disorder Scale; Lowe et al., 2008), mathematics anxiety (using the 9-item Abbreviated Math Anxiety Scale; Hopko et al., 2003), and spatial anxiety using a new 10-item questionnaire adapted from the Wayfinding Strategy Scale (Lawton, 1994). This questionnaire included items related to navigation and wayfinding, as well as mental rotation and visualisation. Exploratory and confirmatory factor analyses revealed a four-factor model. Items related to mathematics anxiety loaded onto the first factor and items related to general anxiety loaded onto the second factor. A third and fourth factor distinguished navigation anxiety and rotation/visualisation anxiety from the spatial anxiety questionnaire. Thus, demonstrating that spatial anxiety is an independent multifactorial construct. That is, spatial anxiety entails apprehension towards: 1) larger-scale navigation scenarios and 2) smaller-scale spatial skills, such as, mental rotation, visualization, and object manipulation. In the current work, however, I focus on spatial anxiety in the context of navigation using Lawton's (1994, 1996) and Lawton and Kallai (2002) Spatial Anxiety Scale.

As well as presenting a distinct factor structure (Malanchini et al., 2017), each anxiety construct comprises unique genetic factors. For instance, genetic factors explained 37% of the individual differences specific to navigation anxiety. Although each anxiety construct (i.e., general, mathematics, navigation, and rotation/visualization) showed some common genetic and non-shared environmental factors. Overall, findings indicated a large degree of specificity in the genetic and environmental aetiology of general and context-specific anxiety.

1.7 Virtual Environment Methodology

Throughout my studies, I used virtual environment technology. Virtual environments are computerised interfaces widely used in spatial cognition research. A virtual environment comprises a "three-dimensional data set describing an environment based on real-world or abstract objects and data" (Blade & Padgett, 2002, p. 26). Virtual platforms are safe, controlled, and can appear life-like. If a user commits multiple errors, harm is minimal and the navigation activity itself requires little physical effort. Virtual environments can also be easily personalised; for example, the experimenter can design the layout of a spatial route and select the content and placement of landmarks. Although virtual environments provide visual stimuli, they do fail to provide other forms of sensory stimulation involved in real-world locomotion, such as vestibular, proprioceptive, and efferent information (Waller et al., 2007). Desktop virtual environments, for instance, are typically stationary, displayed by a computer monitor and controlled by common devices such as a keyboard, game pad, or joystick. However, virtual technology that does simulate sensory input beyond vision is complex to set-up and can therefore be highly expensive. Although the ecological validity of virtual environments can fall short in terms of movement through large-scale environments, researchers have demonstrated that the acquisition of spatial knowledge is comparable to that derived from real-world navigation (Richardson et al., 1999; Hegarty et al., 2006). A number of studies have shown that performance in the real-world highly correlates with virtual computerised tasks, including among vulnerable groups such as people with mild cognitive impairment, AD, and schizophrenia (Aubin et al., 2018; Coutrot et al., 2019; Cushman et al., 2008; Kalová et al., 2005). In contrast to the real-world, virtual environments offer flexibility in design and experimental control, which allow researchers to address important research questions. Scholars have remarked that despite the drawbacks of virtual environments, in certain situations, they are outweighed by the advantages (Lokka et al., 2018).

1.7.1 Using Virtual Environments to Induce Spatial Anxiety

I develop a novel spatial-anxiety induction within a virtual environment (Chapter 2). I then implemented this induction, to test the first part of the regulatory model—whether spatial anxiety triggers increased nostalgia (Chapter 3). Previous studies have used virtual environments to evoke affective states, such as sadness, relaxation, joy, and fear

(Baños et al., 2012; Felnhofer et al., 2015; Riva et al., 2007; Toet et al., 2009). Three experiments manipulated environmental conditions to induce fear. Riva et al. (2007) and Felnhofer et al. (2015), for example, altered the audio cues and intensity of lighting in a virtual park and found this successfully elicited a fearful state. Whereas, Toet et al. (2009) found that a darkened (compared to a brightened) virtual village did not evoke fear, even after an acute stress task (i.e., Trier Social Stress Test).

Lynch (1960) identified getting lost as an anxiety-provoking experience that is intimately connected to one's sense of emotional security. Although researchers have exposed participants to threatening sensory stimuli, no study has simulated the experience of becoming lost within a virtual environment. In Chapter 2, I filled this gap by developing an experimental paradigm for investigating spatial anxiety.

1.7.2 Using Virtual Environments to Induce Nostalgia

In Chapter 3, I develop a new experimental induction of nostalgia. Specifically, I induced nostalgia using pictures, which I then embedded within a virtual interface. Other researchers have utilised visual stimuli to evoke nostalgia. Brain imaging studies, for instance, have used personal family photographs (Gilboa et al., 2004; Cox et al., 2015) and images of childhood items such as, a school pencil case and chewing gum (Oba et al., 2016; Yang et al., 2021). Whereas, media studies have drawn content from beloved children's shows, cartoons, and film trailers (Wulf et al., 2019). Using similar content, I generated nostalgic (versus non-nostalgic) pictures and wall-mount the images within a virtual environment to manipulate nostalgia.

1.8 Alzheimer's Disease, Navigation, and Nostalgia

The second key objective of my thesis was to extend the benefits of nostalgia within a spatial setting to a relevant clinical group. For people living with AD, getting lost in both unfamiliar and familiar settings is a common occurrence. Spatial disorientation is one of the first symptoms to surface and often continues throughout AD progression

(Alexander & Geschwind, 1984; Liu et al., 1991). At early stages of the disease, up to 55% of people experience difficulties with navigation (Chiu et al., 2004), especially when learning new routes (Cushman et al., 2008; Kavcic & Duffy, 2003; Rainville et al., 2001). The fear that evolves from becoming lost can increase spatial anxiety (Lawton, 1994; Lawton & Kallai, 2002), and thwart future endeavours to travel to a known place or explore a new environment (Kaplan et al., 1998). In turn, this can diminish quality of life, autonomy, and socialisation opportunities (Passini et al., 2000), highlighting the importance of tackling such challenges. First, I outline the prevalence, diagnosis, and pathology of AD, before discussing current treatments and psychosocial interventions. Next, I review the evidence thus far that has investigated the benefits of nostalgia for people with dementia. I then outline the application of nostalgia within spatial environments for people living with AD.

1.9 Alzheimer's Disease: Prevalence, Diagnosis, and Pathology

Dementia is an umbrella term used to describe a set of symptoms involving problems with memory and thinking skills. Given the growth of aging populations and increased life expectancy, the prevalence of dementia is predicted to rise significantly. In the UK, older adults occupy 22% of the population (Centre for Ageing Better, 2021), and approximately, 885,000 older adults live with dementia (Wittenberg et al., 2019). Worldwide, by 2050, cases of dementia are projected to reach 115.4 million (Prince et al., 2013). Among older populations, dementia is the primary contributor to disability and dependence (Sousa et al., 2009). Hence, many developed countries regard it as a high-priority medical and social problem.

AD is one of the most common underlying pathologies of dementia, accounting for 60% of dementia cases. It is a neurodegenerative condition characterised by a progressive decline in cognitive ability and independence. Clinically, a diagnosis of probable AD requires a history of memory loss, including deficits in at least one other cognitive domain (e.g., visuospatial, language, and executive functions; McKhann et al., 1984, Jack, et al., 2011). AD symptomology reflects neuropathological changes in the brain. Abnormal proteins (i.e., amyloid-β plaques, neurofibrillary tangles) form and accumulate in a distinct pattern across multiple brain regions, with the tangles preceding the plaques in six stages (Braak & Tredici, 2015). The tangles first present in the trans-entorhinal cortex (stage 1), followed by the entorhinal cortex and Ammon's horn in the hippocampus (stage 2). The tangles then spread to the amygdala, anterodorsal thalamic nucleus, and the remainder of the hippocampus (stage 3). Lastly, the tangles advance to nearby regions within the cerebral cortex (stage 4-6; Medina & Avila, 2014). Typically, amyloid-β plaques first appear in the prefrontal brain regions and later become widespread over the cortex. The joint extra- and intra-cellular deposition of plaques and tangles inevitably results in neuronal cell loss and brain atrophy.

1.10 Alzheimer's Disease: Treatments and Interventions

As it stands, there is no current cure for AD. People diagnosed with AD have several treatment options, at different stages of the condition. Medications are prescribed to help alleviate symptoms by slowing their progression and, in some cases, stop symptom progression (Shash et al., 2015; Cumbo & Ligori, 2014). The most commonly prescribed medications include: Aricept (Donepezil), Galantamine (Reminyl), Rivastigmine (Exelon), and Memantine (Ebixa)—all of which improve memory, activities of daily living, alertness, and levels of interest (Birks & Evans, 2015). The downside of pharmaceutical drugs are the unpleasant side effects, for example, nausea, diarrhoea, headaches, insomnia, dizziness, and muscle cramps (Li et al., 2015; Wahab et al., 2013; Deardorff et al., 2015; Zemek et al., 2014; Atti et al., 2014; Ali et al., 2015).

Alongside medication, health care professionals advise engaging with psychosocial interventions to enhance well-being and quality of life (Patel et al., 2014). In particular, adopting a person-centred approach is a vital part of supporting and caring for a person with dementia. The core principle of this approach is that people with dementia should be treated as individuals with their own identity and life story, rather than through a medical lens, which identifies their deficits and difficulties (Kitwood, 1997; Sabat, 2001).

Over the years, a broad range of psychosocial interventions has been developed (Patel et al., 2014). In dementia care, reminiscence is one of the most popular interventions and, increasingly, has received scholarly attention. Emerging in the late 1970s (Kiernat, 1979), reminiscence involves recalling past events and experiences in a person's life (Coleman, 2005), often with tangible prompts (e.g., photographs, familiar items from the past, music, video clips) guiding discussion within a group setting. A Cochrane review on reminiscence therapy for people with dementia outlined some positive findings regarding improvements in mood and cognition. However, these studies were either small or of poor quality (Woods et al., 2005). Larger trials continued to show some positive effects on mood and cognition (Wang, 2007; Tadaka & Kanagawa, 2004, 2007) but, since then, a major high-quality randomised controlled trial found no support for the effectiveness of reminiscence therapy (Woods et al., 2012). Compared to usual care, reminiscence made no significant changes to quality of life for people with dementia. Instead, caregiver stress and anxiety worsened. Reliving past life events, via reminiscence-related activities, not only triggers ordinary memories but also nostalgic ones (Coleman, 2005). There are clear distinctions between nostalgic and non-nostalgic memories. In contrast to reminiscence, there is a large body of scientific research demonstrating the psychological benefits of nostalgia in non-clinical populations (Hepper et al., 2012; Sedikides et al., 2016; Sedikides & Wildschut, 2019; Stephan et al., 2012; Wildschut et al., 2006; Zhou et al., 2008).

1.11 Alzheimer's Disease and Nostalgia

In recent years, the psychological benefits of nostalgia have been investigated in the dementia field. In three experiments, Ismail et al. (2018) manipulated nostalgia among people with early to moderate stage dementia. In Experiments 1 and 3, participants recalled a nostalgic (compared to ordinary autobiographical) event. Nostalgic (relative to ordinary) event reflection significantly boosted feelings of social connectedness, self-continuity, meaning in life, self-esteem, and optimism. In Experiment 2, the researchers induced nostalgia using music. During recruitment, participants listed three songs that made them feel nostalgic. Participants entered the experiment in pairs, with one person randomly allocated to the nostalgia condition and the other to the control condition. Participants in the nostalgia condition listened to the song they had previously listed as nostalgic. Each control participant was yoked to a participant in the nostalgia condition and listened to the same song as that person. Thus, the same song was presented to both participants, but it had only been identified as evocative of nostalgia for one of them. Similar to the other experiments, music-evoked nostalgia increased social connectedness, self-continuity, meaning in life, self-esteem, and optimism. Nostalgia enhanced the psychological wellbeing of people with dementia.

The content of nostalgic memories for people with dementia is similar to the content of nostalgic memories reported in non-clinical samples. Ismail et al. (2021) administered the ERT and analysed 36 nostalgic and 31 control narratives of people with dementia. Nostalgic narratives mostly featured atypical events comprising emotional content (e.g., graduation, weddings), whereas control narratives mostly featured a routine event of neutral emotional content. As expected, nostalgic memories contained more references to high self-esteem and self-continuity, as well as greater positive affect and meaning in life. In particular, nostalgic narratives presented more social words that related to loved ones from the past (e.g., family and friends) and contained more references to companionship, affiliation, and close relationships.

Dodd et al. (2022) developed an intervention that could harness nostalgia's benefits for people living with dementia over a longer time period. They achieved this by consulting the public (including people with lived experience of dementia) on their general feelings about nostalgia and the ways in which nostalgia could be a useful intervention in everyday life. An individualised, home-based intervention emerged, consisting of a workbook that guided a person with dementia and their caregiver in how to blend nostalgia into daily conversation. Six couples took part in the 5-week intervention. Each couple was assigned a nostalgia coach who introduced the workbook and offered regular support throughout the intervention by phone or face-to-face. The workbook prompted couples to reflect on their personal nostalgic memories, including possible triggers (e.g., photographs, places, and music). The couples recorded their memories in the workbook, which became a point of discussion with the nostalgia coach who would then support each couple in how to integrate nostalgic conversations into their daily routine. At baseline and at a 5-week follow-up session, participants with dementia rated their levels of self-esteem (using the Rosenberg Self-Esteem scale; Rosenberg, 1989), self-growth, meaning in life, and social connectedness (using the Personal Growth, Purpose in Life, and Positive Relations with Others subscales of the Psychological Wellbeing Scale; Ryff, 1989). Caregivers rated their level of social connectedness with their partner (using the Satisfaction with the Care Recipient subscale of the Sense of Competence Questionnaire; Jansen et al., 2007). All six couples successfully engaged in the intervention, with each one presenting a numerical change or improvement in at least one function of nostalgia. Participants with dementia presented the strongest improvement for levels of personal growth. Overall, the findings indicated that a nostalgia-infused intervention may boost self-esteem, self-growth, meaning in life, and social connectedness for people living with dementia.

1.12 A Nostalgia Intervention Among People Living with Alzheimer's Disease

As previously discussed, people with AD experience difficulties with navigation (Bellassen et al. 2012; Monacelli et al. 2003). These AD-related deficits are commonly attributed to the structural and functional changes that occur in the hippocampus— a crucial brain region associated with spatial learning and spatial memory (Coughlan et al., 2018; O’Keefe & Nadel, 1978). In addition, AD causes deficits in visual attention (Rizzo et al., 2000), which can hamper a person’s ability to attend to relevant sensory input in the environment, such as landmarks. More often than not, indoor environments are poorly designed, with long, similar-looking corridors, which are confusing to navigate (Passini, 1984; Passini et al., 2000). UK policy directives have addressed the importance of creating enabling environments for people living with dementia, not only to support spatial navigation but also to promote well-being (Department of Health, 2015). These design guidelines recommend installing distinct, recognisable landmarks to assist a person with dementia with navigation. Researchers and laypeople specifically recommend that environmental cues are personally relevant and serve to trigger positive emotions (Kris & Henkel, 2019; O'Malley et al., 2018). Kris and Henkel (2019), for example, recommend utilising autobiographically-salient pictures to preserve the sense of self and stimulate emotions, such as nostalgia. Designing personalized environments in this way can assist the delivery of person-centered care for people with memory loss (Edvardsson, 2008). I therefore further developed the nostalgic picture induction in Chapter 4 and tested whether it confers psychological benefits for people living with AD, a clinical population that experiences navigational challenges in everyday life.

Chapter 2: Empirical Paper I

In this chapter, I develop a novel protocol for inducing spatial anxiety within a virtual environment. A spatially anxious navigator is generally slower, commits more errors, travels longer distances in order to reach a desired destination, and is more likely to get lost in the process (Hund & Minarik, 2006; Walkowiak et al., 2015). At some stage, most people experience episodes of disorientation. Typically, this occurs when a navigation endeavour fails in some way. The immediate surroundings become unfamiliar and the navigator lacks insight into their current location and the correct path that returns them to a familiar place. Thus far in the literature, not one study has developed an experimental paradigm to investigate the causal effects of spatial anxiety. Given that disorientation is an adverse spatial-related experience, I simulate a getting lost experience within a virtual environment to induce spatial anxiety.

The paper that follows was submitted and accepted by the journal, *Behaviour Research Methods*. My contribution to the paper involved obtaining ethical approval, collecting and analysing the data, drafting the manuscript, incorporating feedback from the other authors and journal reviewers, and developing the virtual environment software, including an instruction manual for future users.

Induction of Spatial Anxiety in a Virtual Navigation Environment

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Abstract

Spatial anxiety (i.e., feelings of apprehension and fear about navigating everyday environments) can adversely impact people's ability to reach desired locations and explore unfamiliar places. Prior research has either assessed spatial anxiety as an individual-difference variable or measured it as an outcome, but there are currently no experimental inductions to investigate its causal effects. To address this lacuna, we developed a novel protocol for inducing spatial-anxiety within a virtual environment. Participants first learnt a route using directional arrows. Next, we removed the directional arrows and randomly assigned participants to navigate either the same route (n = 22; control condition) or a variation of this route in which we surreptitiously introduced unfamiliar paths and landmarks (n = 22; spatial-anxiety condition). The manipulation successfully induced transient (i.e., state-level) spatial anxiety and task stress but did not significantly reduce task enjoyment. Our findings lay the foundation for an experimental paradigm that will facilitate future work on the causal effects of spatial anxiety in navigational contexts. The experimental task is freely available via the Open Science Framework (https://osf.io/uq4v7/).

2.1 Induction of Spatial Anxiety in a Virtual Navigation Environment

Spatial disorientation has negative practical and emotional consequences (Lynch, 1960) and can undermine confidence in performing wayfinding tasks, resulting in spatial anxiety or feelings of apprehension and fear about environmental navigation (Lawton, 1994). Spatial anxiety is a domain-specific construct or "surface" trait, referring to negative emotions that arise exclusively within spatial contexts (Lyons et al., 2018; Malanchini et al., 2017; Mckeen, 2011; Vieites et al., 2020). Broader constructs such as general anxiety are domain-general or "personality" traits. General anxiety is associated with neuroticism, which denotes negative affectivity and vulnerability to stress (Cox et al., 1999). Various anxiety constructs (e.g., general, mathematics, test, spatial), although interrelated, are distinct (Alvarez-Vargas et al., 2020; Malanchi et al., 2017; McKheen, 2011), with each construct comprising unique genetic factors (Malanchi et al., 2017). Individual differences in spatial anxiety are not fully explained by general anxiety (Alvarez-Vargas et al., 2020). For example, general anxiety, as opposed to spatial anxiety, does not relate to navigation ability (Walkowiak et al., 2015), indicating that people high in general anxiety are not necessarily high in spatial anxiety, and vice versa. Thus, domain-general and domain-specific anxiety should be treated separately.

It has been widely accepted that anxiety hinders cognitive performance (Maloney et al., 2014; Moran, 2016; Sandi, 2013). Compared to other types of anxiety (i.e., general, mathematics, test), spatial anxiety is arguably the most understudied. Past research has found that self-reported spatial anxiety is negatively correlated with navigation performance, in terms of reducing speed and increasing errors (for a review see, Coluccia & Louse, 2004; Hund & Minarik, 2006; Walkowiak et al., 2015). Prior correlational studies have operationalised spatial anxiety using self-report questionnaires (Lawton, 1994, 1996). However, inferences drawn from correlational designs are limited, and the direction of causality between relatively poor navigation and relatively high spatial anxiety remains unclear (Weisberg & Newcombe, 2018). Experimental procedures to directly induce spatial anxiety within a spatial task are currently lacking. To address this lacuna, we developed a novel protocol for manipulating spatial anxiety within a virtual environment.

Virtual environments offer flexible, interactive design features which can be controlled and displayed from a 3D first-person perspective (Richardson et al., 1999). Virtual platforms are also safe; if the user makes navigational errors, harm is minimal. Although virtual environments provide visual stimuli, they do lack vestibular, proprioceptive, and efferent information which is present during real-world navigation. Despite this, the acquisition of spatial knowledge can be simulated to resemble real-world settings (Ruddle et al., 1997). Several studies have shown that performance in the real world is comparable to performance in virtual tasks, including in clinical populations such as people with mild cognitive impairment, AD, and schizophrenia (Aubin et al., 2018; Coutrot et al., 2019; Cushman et al., 2008; Kalová et al., 2005), making virtual environments a cost-effective and ecologically valid tool. Moreover, researchers have used virtual environments to induce transient affective states, such as sadness, relaxation, joy, and fear (Baños et al., 2012; Felnhofer et al., 2015; Riva et al., 2007; Toet et al., 2009). Three studies in particular altered environmental conditions to induce fear. Riva et al. (2007) and Felnhofer et al. (2015) modified the audio cues and intensity of lighting in a virtual park and successfully evoked a fearful state. However, Toet et al. (2009) found that active exploration of a darkened (compared to a brightened) virtual village did not elicit fear, even after an acute stress task (i.e., Trier Social Stress Test).

Lynch (1960) identified getting lost as an anxiety-provoking experience that is intimately connected to one's sense of emotional security. Although researchers have exposed participants to adverse sensory stimuli in virtual environments, to date no study has simulated the experience of becoming lost. Here, we aim to fill this gap and, by so doing, develop an experimental paradigm for investigating spatial anxiety. We implemented our spatial-anxiety manipulation in a virtual route-learning task and assessed its impact on transient (i.e., state-level) spatial anxiety and affect.

2.2 Method

2.2.1 Participants and Design

Forty-six University of Southampton undergraduate students (31 women, 13 men) took part in a 40-min experiment in return for course credit. The experimenter terminated the study early for two participants (one participant felt unwell and one experienced a computer error). We excluded these participants from all analyses. Participants' age ranged from 18 to 29 years (M = 20.20, SD = 2.24). Participants' ethnicities were: White British (n = 34), other white background (n = 4), Caribbean (n = 2), Bangladeshi (n = 1), Indian (n = 1), Pakistani (n = 1), African (n = 1), other Asian background (n = 1), and other mixed background (n = 1). All participants had normal or corrected to normal (soft contact lenses or glasses) vision. We randomly assigned participants to one of two conditions: spatial anxiety (n = 22) and control (n = 22). We conducted a power analysis using G*Power 3.1 (Faul et al., 2007). Our key objective was to demonstrate the effectiveness of the spatial-anxiety manipulation. As such, the primary outcome variable was transient or state-level spatial anxiety and, based on pilot testing, we anticipated a large effect (d = 1.00). The power analysis indicated a requisite sample size of 34 to achieve power equal to .80 (two-tailed alpha = .05). We exceeded this target to hedge against attrition. This study received ethical approval from the University of Southampton Ethics Committees (2019-31054).

2.2.2 Virtual Environment

We used the Unity development platform to create a Windows desktop application of a virtual 3D maze environment, which is freely available for download. Exploration through the environment presented a first-person perspective (Figure 2.1). The programme restricted the participant's view to a static plane, in that they could not manoeuvre their gaze up or down. To control movement through the maze, participants used the arrows keys “FORWARD,” “BACKWARD,” “LEFT,” and “RIGHT” on the keyboard. The maze route only included perpendicular turns. Along the maze route, the walls displayed 10 local landmarks. The local landmarks comprised 2D colourful pictorial images, such as apple, tree, bus, or wallpaper patterns. Outside the maze, but within distal view, four global landmarks were located at each cardinal reference point. The global landmarks depicted a hot air balloon, moon, high-rise buildings, and a mountain-range scene. The local and global landmarks functioned as spatial reference points to aid navigation.

2.2.3 Procedure and Materials

After reading the information sheet, participants provided consent and then, completed demographic information. Next, they started the route-learning task. This task consisted of three training trials and one test trial. On the training trials, directional arrows were present in the maze, and participants followed these arrows to navigate from a starting point to an end destination. The training route involved 10 turns (Maze 1; Figure 2.2).

Next, participants completed the test trial, where the directional arrows were absent. Participants in the control condition navigated the same maze (Maze 1) as in the training trials. Participants in the spatial-anxiety condition navigated Maze 2 (Figure 2.3), a variation of the maze used in training. In Maze 2, the route from the starting point to the fifth turn was the same as in Maze 1. When participants passed the fifth turn, however, the maze presented additional paths with dead ends and four unfamiliar local landmarks. After the ninth turn, the route returned to the original layout and appearance of Maze 1. If participants were unable to complete the critical trial within 4 minutes, the experimenter guided them to the end destination. Immediately after the route-learning task, participants completed the following measures.

State Spatial Anxiety. We adapted the Spatial Anxiety Scale (Lawton & Kallai, 2002) to measure transient, state-level spatial anxiety. Participants rated (1 = *not at all* *anxious*, 5 = *very anxious*) how anxious they would feel "Right now, that is, at this present moment" in relation to eight hypothetical navigation scenarios (e.g., "Finding my way to an appointment in an unfamiliar area of a city or town," "Trying a new route that I think will be a shortcut, without a map"; α = .91, M = 3.02, SD = 0.91).

Task Experience. Participants evaluated (1 = *strongly disagree*, 6 = *strongly agree*) their task experience on 15 items (e.g., "The navigation task was enjoyable"), which we submitted to an exploratory factor analysis. We used parallel analysis (Horn, 1965) and minimum average partial correlation (MAP) analysis (Velicer, 1976) to determine the number of factors to retain. In addition, we examined eigenvalues and the proportion of common variance explained by each factor. All criteria pointed to a 2-factor solution (see Table 2.1), with the two main factors jointly accounting for 80% of the common variance. The obliquely rotated (promax) factor pattern displayed simple structure. The items "stressed," "difficult," "frustrated," "doubt my ability," "anxious," "something I am good at" (negatively), and "easy" (negatively) loaded exclusively on the first factor (factor loading > .50), which we labeled Task Stress (α = .90, M = 3.40, SD = 1.08). The items "fun," "engaging," "interesting," "exciting," "enjoyable," "something I would like to do again," "boring" (negatively), and "tedious" (negatively) loaded exclusively on the second factor, which we labeled Task Enjoyment (α = .88, M = 4.62, SD = 0.72). A debriefing concluded the experiment.

Control Variable. We administered two trait-level measures assessing dispositional individual differences in spatial anxiety. Both scales assessed how anxious participants feel in general (rather than at the present moment) in relation to hypothetical navigation scenarios. We did not expect that our momentary induction of spatial anxiety would alter dispositional spatial anxiety. Rather, we controlled for this trait to ascertain that any effects of the spatial-anxiety induction were not due to (or obscured by) pre-existing differences between conditions in dispositional spatial anxiety. Random assignment guards against such pre-existing differences but does not rule them out. The revised Spatial Anxiety Scale (Lawton & Kallai, 2002) comprises eight items (e.g., "Finding my way to an appointment in an unfamiliar area of a city or town") that were rated on a 5-point scale (1 = *not at all anxious*, 5 = *very anxious*; α = .81, $M = 2.86$, $SD = 0.67$). The Spatial Anxiety Questionnaire (Malanchini et al., 2017) includes ten items (e.g., "Finding your way around an intricate arrangement of streets") that were rated on a 5-point scale (1 = *not at all anxious*, 5 = *very anxious*; α = .80, $M = 2.40$, $SD = 0.59$). We pooled the 18 items across both scales to create an overall index of dispositional spatial anxiety (α = .89, $M = 2.67$, $SD = 0.67$).

2.3 Results

2.3.1 State Spatial Anxiety

Participants in the spatial-anxiety condition ($M = 3.47$, $SD = 0.77$) reported significantly higher levels of state-level spatial anxiety than participants in the control condition ($M = 2.57$, $SD = 0.82$), $t(42) = 3.75$, $p < .001$, $d = 1.13$. Further, the mean spatial-anxiety score in the spatial-anxiety condition ($M = 3.47$, $SD = 0.77$) significantly exceeded the scale midpoint (= 3), $t(21) = 2.86$, $p = .009$. The induction of spatial anxiety was successful, both in comparison to the control condition and relative to the scale midpoint.

2.3.2 Task Experience

Participants in the spatial-anxiety condition ($M = 4.24$, $SD = 0.74$) scored significantly higher on the Task Stress scale than participants in the control condition ($M = 2.56$, $SD = 0.62$), $t(42) = 8.18$, $p < .001$, $d = 2.47$. The spatial-anxiety ($M = 4.64$, $SD = 0.64$) and control ($M = 4.60$, $SD = 0.81$) conditions did not differ significantly on Task Enjoyment, $t(42) = 0.18$, $p = .860$, $d = 0.05$.

We also tested the effect of the spatial anxiety manipulation on each task-experience item, using a Bonferroni-adjusted alpha level of .0033 (.05/15). We present the results in Table 2.2, in descending order of effect size. Participants in the spatial-anxiety condition (compared to controls) were more frustrated, stressed, and anxious. They were also more likely to indicate that the route-learning task was difficult and made them doubt their ability, and less likely to think the task was easy and something they were good at.

2.3.3 Controlling for Dispositional Spatial Anxiety

As intended (by random assignment), participants in the spatial-anxiety ($M = 2.71$, $SD = 0.69$) and control ($M = 2.64$, $SD = 0.67$) condition did not differ on dispositional spatial anxiety, $t(42) = 0.34$, $p = .733$, $d = 0.10$. When we repeated our analyses with the addition of dispositional spatial anxiety as a covariate, effects of the spatial-anxiety manipulation were essentially unchanged. Results did, however, reveal an important additional finding—dispositional spatial anxiety was positively and significantly associated with transient, state-level spatial anxiety in the navigation task, $b^* = .49$, $t(41) = 4.45$, $p < .001$. This provides construct validation for the state-level spatial anxiety measure (Campbell & Fiske, 1959).

2.4 Discussion

Results supported the effectiveness of our spatial-anxiety induction. Participants in the spatial-anxiety condition, who navigated a maze in which we had surreptitiously introduced unfamiliar elements, reported higher levels of transient spatial anxiety, both in comparison to control participants and relative to the scale midpoint. Task evaluations revealed that the spatial-anxiety induction evoked a mix of stress, anxiety, frustration, and doubt in one's spatial ability. These results are in line with previous studies that successfully used virtual environments to trigger emotions, such as sadness, relaxation, joy, and fear (Baños et al., 2012; Felnhofer et al., 2015; Riva et al., 2007). Prior virtual designs altered visual and audio features (e.g., darkness, unpleasant noises). Our task is novel in that we simulated the experience of becoming lost—an adverse spatial-related experience (Lynch, 1960).

We demonstrated that virtual platforms are an effective tool for inducing emotions related to navigation. Virtual environments present a life-like interface and the acquisition of spatial knowledge in virtual environments closely resembles real-world navigation (Coutrot et al., 2019; Cushman et al., 2008; Hegarty et al., 2006; Ruddle et al. 1997; Richardson et al., 1999), thus strengthening ecological validity. Further, virtual-environment technology can be readily implemented on personal computers without requiring specialist equipment and can be shared with other researchers and laboratories (Wiener et al., 2020). The protocol we have described here can be accessed free of charge and without restriction: https://osf.io/uq4v7/.

Past research has assessed the effects of acute, generalized anxiety or fear on spatial navigation by using context-irrelevant stressors such as the Trier Social Stress Test (Toet et al., 2009), threat of shock technique (Cornwell et al., 2012), the cold pressor test (Duncko et al., 2007), and a restricted breathing exercise (Ruginski et al., 2018). To date, however, no studies have implemented specific experimental inductions of spatial anxiety. A direct manipulation of spatial anxiety will allow future researchers to examine its effect on spatial cognition and related constructs, such as motivation to explore, navigation experience, strategy preferences, and spatial confidence. Incorporating spatial-anxiety inductions in future studies will help to disambiguate the causal direction of the relation between spatial anxiety and navigation ability, as well as identify mediating mechanisms. Clarifying such mechanisms could inform training programs designed to improve spatial skills (Lovden et al., 2011; Uttal et al., 2013), especially for spatially anxious navigators.

2.4.1 Limitations and Future Directions

We acknowledge several limitations. First, our sample lacked representative diversity in gender, race, and age. Future studies should validate the spatial-anxiety induction in more diverse samples to assess its generalizability. Second, although our manipulation successfully induced spatial anxiety, we cannot rule out that it also heightened general anxiety. Domain-specific and general anxiety constructs are only modestly correlated (Alvarez-Vargas et al., 2020, McKheen, 2011) and this limited overlap is primarily due to genetic rather than environmental factors (Malanchini et al., 2017). Nonetheless, future research should assess the specificity of our spatial-anxiety induction to ascertain that its effects are uniquely attributable to spatial, and not general, anxiety. An important next step, then, is to include measures of general anxiety (Lowe et al., 2008; Ree et al., 2008), as well as physiological parameters (e.g., increased heart rate, reduced heart rate variability [Howell & Hamilton, 2022], elevated skin conductance levels [Murty et al., 2011]). By so doing, future studies could strengthen the current findings and enhance our understanding of the specific effects of spatial anxiety. Third, our spatial anxiety procedure is a composite manipulation, in that it introduces (1) a more complex maze route and (2) breaks down established contingencies (i.e., pairings between learnt cues and associated turns at junctions). Future studies should address whether spatial anxiety within the maze results from altering the maze complexity, disrupting cue pairings, or both. Doing so would disambiguate the spatial modification accountable for triggering spatial anxiety.

The new spatial-anxiety manipulation has potential future applications. Strong spatial skills are key for success in science, technology, engineering, and mathematics (STEM) fields (Kell et al., 2013; Wai et al., 2009). Uttal et al. (2013) outlined the malleable yet transferable nature of spatial skills, which is encouraging for researchers keen to help those who are spatially anxious. So far, interventions alleviating domain-general anxiety have proven unsuccessful when applied to specific contexts (e.g., mathematics anxiety; Sharp et al., 2000; Zettle, 2003). Better understanding of spatial anxiety may help develop targeted, domain-specific interventions (Malanchini et al., 2017), which could enhance spatial skills and, in turn, diversify participation in STEM fields. Additionally, investigating the causal effect of spatial anxiety on navigation ability promises to improve our understanding of populations that experience such difficulties in day-to-day life. For example, people living with dementia of the Alzheimer's type frequently experience spatial anxiety (Chiu et al., 2004; Davis & Veltkamp, 2020; Mahoney et al., 2000; Tu & Pai, 2004). Enhanced insight into the causal effects of spatial anxiety could inform interventions to combat the psychological and practical consequences associated with impaired navigation in this and other vulnerable populations.

Table 2.1

Factor Analysis for the Task Experience Questionnaire (N = 44): Rotated Factor Pattern

Items	Factor Loading	
	1	2
Factor 1: Task Stress		
7. Stressed	.85	-
11. Difficult	.81	-
9. Frustrated	.76	-
10. Doubt my ability	.66	-
8. Anxious	.65	-
15. Good at	-.80	-
4. Easy	-.80	-
Factor 2: Task Enjoyment		
2. Fun	-	.85
13. Engaging	-	.83
14. Interesting	-	.81
3. Exciting	-	.78
1. Enjoyable	-	.68
12. Do again	-	.59
5. Boring	-	-.55
6. Tedious	-	-.72

Note. Factor loadings smaller than .50 are omitted.

Table 2.2

Means and Standard Deviations for Affect Items by Condition

	Spatial anxiety	Control			
	M (*SD*)	*M* (*SD*)	*t*	*p*	*d*
Frustrated	3.95 (1.22)	1.64 (0.79)	7.51	< .001	2.26
Difficult	4.27 (1.16)	2.50 (0.80)	5.89	< .001	1.78
Easy	2.82 (1.10)	4.36 (0.79)	-5.36	< .001	-1.62
Stressed	4.14 (0.94)	2.55 (1.10)	5.15	< .001	1.55
Something I am good at	2.68 (1.36)	4.32 (0.78)	-4.90	< .001	-1.48
Doubt my ability	4.73 (1.20)	2.95 (1.36)	4.58	< .001	1.39
Anxious	4.09 (1.11)	3.00 (1.20)	3.14	.003	0.94
Engaging	5.05 (0.79)	4.55 (0.96)	1.89	.066	0.57
Interesting	5.00 (0.87)	4.59 (0.96)	1.48	.146	0.45
Enjoyable	4.41 (0.73)	4.73 (0.83)	-1.35	.184	-0.41
Something I'd do again	4.00 (1.07)	4.23 (1.11)	-0.69	.493	-0.21
Exciting	4.09 (1.23)	3.91 (1.41)	0.46	.651	0.13
Fun	4.32 (0.89)	4.45 (1.10)	-0.45	.654	-0.13
Boring	2.05 (1.05)	2.09 (0.81)	-0.16	.873	-0.05
Tedious	2.22 (1.02)	2.22 (1.06)	0.00	1.00	0.00

Figure 2.1

Virtual Maze Presentation From a Participant's Perspective.

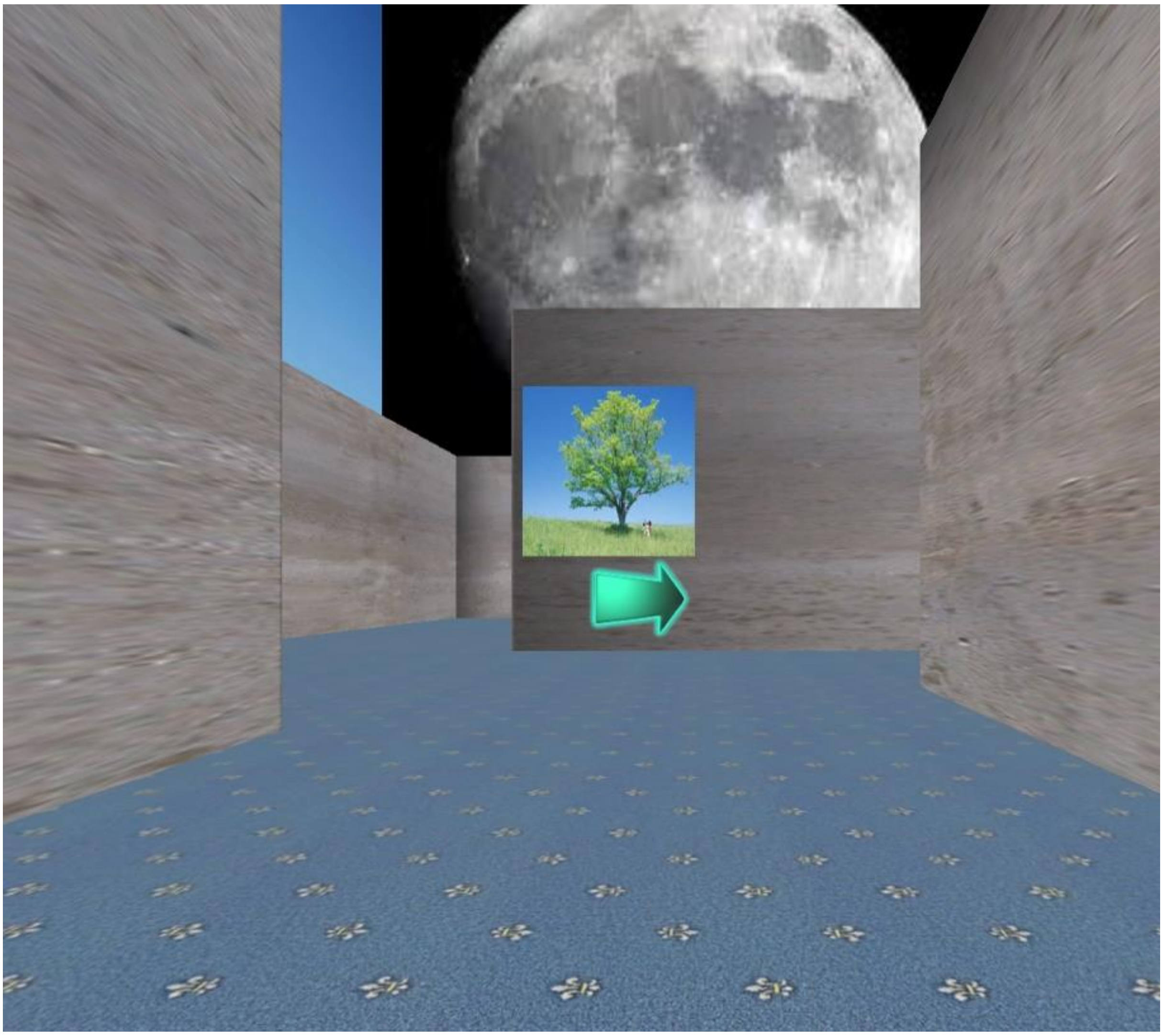
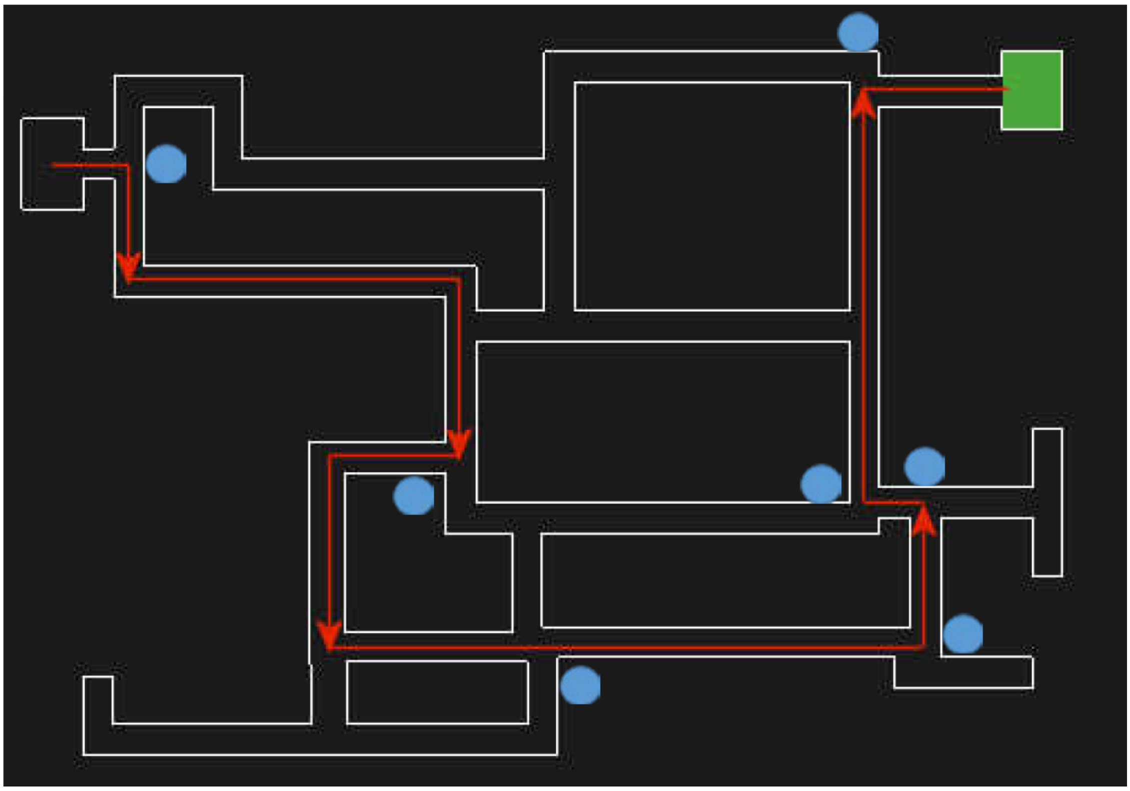


Figure 2.2

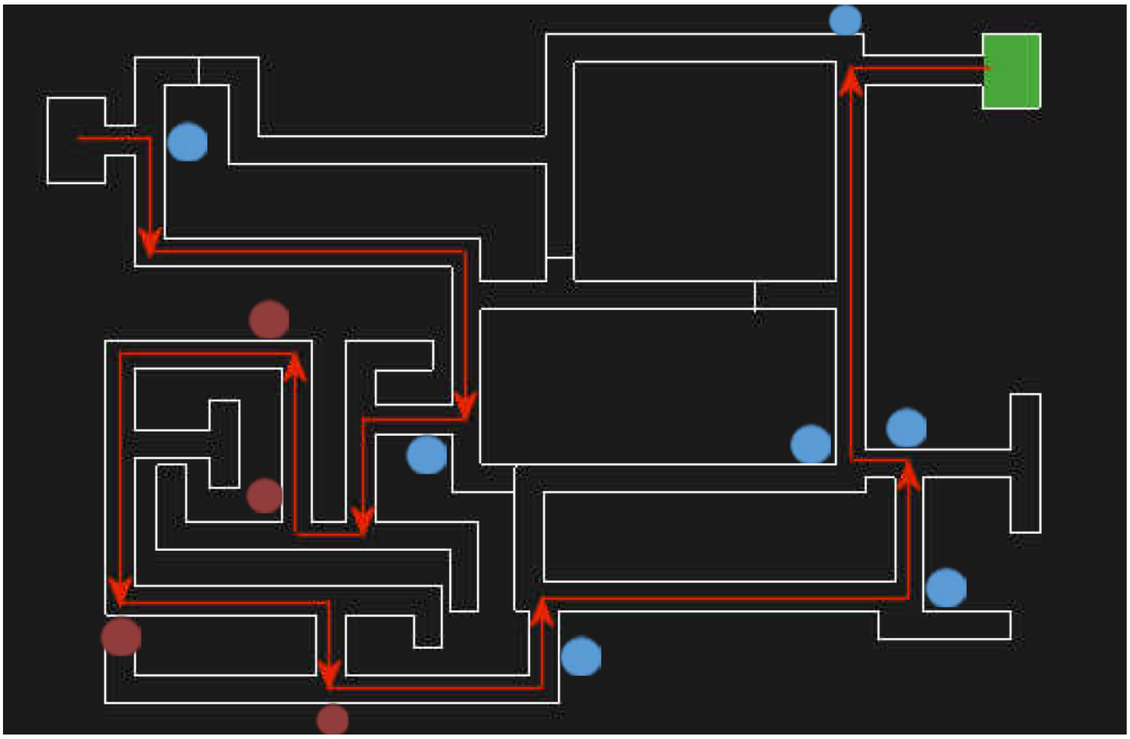
Maze Route 1



Note. Schematic of Maze 1 layout and route. The red arrows illustrate the specified route and the green box indicates the end destination. The blue circles indicate the position of pictures.

Figure 2.3

Manipulated Maze Route 2



Note. Schematic of Maze 2 layout and route for the test trial in the route-learning task. The red arrows illustrate the specified route and the green box indicates the end destination. The blue circles indicate the position of pictures and the red circles indicate the new pictures introduced as part of the spatial-anxiety manipulation.

2.5 Commentary

Chapter 2 presents my first key methodological contribution— a manipulation of spatial anxiety. Here, we take a necessary step and validate the experimental procedure. In terms of effect size it was a success, yielding a Cohen's *d* of 1.13. The data, so far, presents a strong and robust paradigm. However, we need more research that includes a much larger sample with more diverse ethnic backgrounds, age groups, and nationalities. I followed the suit of other researchers like Wiener and colleagues (2020), and I too am 'pro' sharing materials with the wider scientific community. I hope that in making the experimental task available to others, it will help accelerate research in this area—enabling scientific replication and thus, contributing to cumulative science.

A task that allows researchers to adopt experimental paradigms could help unravel potential mechanisms, advancing fundamental research. Offering the scientific community such tools, in time, hopefully will build a richer picture of the relationship between spatial-anxiety and navigation. This new paradigm opens a plethora of future directions and could help answer interesting research questions. All in all, I hope this gets us that bit closer to understanding people who struggle with navigation, whether that be because of spatial anxiety, neurological impairment, or both.

Next on my agenda was to test the effect of the spatial-anxiety manipulation on other, interdisciplinary concepts. In social psychology, individuals find refuge when immersed in nostalgia—an emotion triggered by both physical and psychological threats. Take fluctuations in climatic conditions, for example. When the temperature drops you may address the threat directly by putting on a coat. On an even colder day, despite the extra layer, the temperature feels increasingly uncomfortable. You turn to alternatives, perhaps warm shelter? But say shelter is several miles away. Now you are in a situation where you struggle to gain immediate relief. In that moment, the threat is unavoidable and un-tackle-able. And it is under these aversive states that individual's may nostalgize.

In my next chapter, I shine a spotlight over nostalgia's potential in countering spatial anxiety. I apply the validated spatial-anxiety manipulation in my next Chapter to investigate this further. In terms of the nature of the spatial-anxiety threat, again, I induce spatial anxiety by simulating a "getting lost" experience. In an everyday setting, when you become lost you lose all sense of where you are. To reorient yourself, you may turn to a map or approach a layperson nearby. If successful, you find your way again—threat resolved! But the next time this happens, perhaps you cannot make sense of the map, what if, there is no-one else close by to help. Well now you may start to panic. You may start to wish you were anywhere else but where you are now. You may wish to transport yourself to a place that you know, that is safe and familiar. This leads me onto my next Chapter, where I question—could spatial anxiety spark nostalgia? And in turn can nostalgia lower spatial anxiety?

Chapter 3: Empirical Paper II

In this chapter, I extend the regulatory model of nostalgia to encompass spatial anxiety. I first implement the spatial-anxiety induction procedure in Chapter 2 to test its effect on nostalgia. I then develop a new pictorial nostalgia induction procedure and embed it within a virtual environment to test the effect of nostalgia on spatial anxiety. I generate a selection of nostalgic pictures according to feedback from a young-adult focus group. Similar to Wulf et al., (2019), I selected pictures according to popular childhood media (e.g., Harry Potter, Dexter, Hannah Montana, and Justin Bieber).

The paper that follows is the finalised version of the manuscript that has been submitted to *Emotion*. It was not successful in this journal, my co-authors and I have submitted the manuscript to Journal of Experimental Social Psychology. My contribution to the paper included collecting part the data in Experiment 3.3, analysing the data, drafting the manuscript and incorporating feedback from the other authors.

Nostalgia Assuages Spatial Anxiety

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Abstract

The regulatory model of nostalgia proposes that the emotion is triggered by adverse psychological and physical experiences. Nostalgia, in turn, serves to counter those negative states. We extend this model to encompass spatial anxiety, that is, apprehension and disorientation during environmental navigation. In Experiment 3.1, we induced spatial anxiety by training participants to navigate a route in a virtual maze and then surreptitiously changing part of the previously learned route (spatial-anxiety condition) or leaving the route unchanged (control condition). Consistent with the regulatory model, spatial anxiety (compared to the control) triggered nostalgia. In Experiments 3.2-3, we displayed nostalgic (nostalgia condition) or matched control (control condition) pictures on the walls of a virtual maze. Participants navigated the maze passively (video clip, Experiment 3.2) or actively (computer-based task, Experiment 3.3) and then reported their spatial anxiety. Supporting the regulatory model, nostalgia (compared to control) reduced spatial anxiety (Experiments 3.2-3) and this, in turn, predicted higher goal setting (Experiment 3.3). Nostalgia assuages spatial anxiety during environmental navigation.

3.1 Nostalgia Assuages Spatial Anxiety

Nostalgia, "a sentimental longing or wistful affection for the past" (*The New Oxford Dictionary of English*, 1998, p. 1266), is a prevalent emotion that is experienced throughout life (Batcho, 1995; Hepper et al., 2021; Madoglou et al., 2017; Turner & Stanley, 2021). People generally view nostalgia as a social and past-oriented emotion that involves bringing to mind a fond and meaningful memory, typically of one's childhood or a close relationship. The nostalgizer often sees the remembered event through rose-colored glasses, misses it, and may even wish to return to the past (Hepper et al., 2012). This conceptualization of nostalgia generalizes across cultures (Hepper et al., 2014).

Nostalgia has a distinct bittersweet or ambivalent affective signature, involving a blend of happiness and sadness. Yet, the emotion is predominantly positive or, as Werman (1977) put it, "a joy tinged with sadness" (p. 393). Leunissen et al. (2021) meta-analyzed 41 peer-reviewed studies that experimentally manipulated nostalgia. Participants in the nostalgia conditions of these experiments reported significantly more positive than negative affect (a *positivity offset*; Cacioppo & Berntson, 1994), irrespective of whether the emotion was induced via music, song lyrics, or autobiographical-recall tasks. Experience sampling studies corroborate this positivity offset for everyday nostalgia. Newman et al. (2020, Study 5) instructed undergraduates to rate the positivity and negativity of daily nostalgic experiences on a 7-point scale. Participants evaluated their nostalgic experiences as considerably more positive ($M = 5.02$) than negative ($M = 2.47$). Turner and Stanley (2021) examined daily nostalgic experiences in a lifespan sample comprising young, middle-aged, and older adults. Participants in all three age groups rated their nostalgic experiences as more positive than negative (J. R. Turner, personal communication, August 9, 2022; see also Thibault, 2016).[1]

Nostalgia has also been charted by comparing it with other emotions. Van Tilburg et al. (2018) instructed participants to rate the similarities among 11 emotions, including nostalgia. Multidimensional scaling of these ratings revealed that nostalgia is characterized by high pleasantness and low arousal. Participants viewed nostalgia as most similar to pride, self-compassion, inspiration, and gratitude, and most distinct from shame, hurt feelings, guilt, and embarrassment. Van Tilburg et al. (2019) compared the appraisal profiles of 31 emotions and showed that nostalgia is the only one elicited by unique experiences that feel temporally or psychologically distant and are predominantly pleasant but irretrievable.

The Regulatory Model of Nostalgia

The regulatory model of nostalgia proposes that the emotion serves as a homeostatic corrective that counters the negative effects of adverse psychological and environmental conditions (Sedikides et al., 2015; Wildschut & Sedikides, 2022, in press). An adverse event will have a negative influence on one's current state, but will also trigger nostalgia. Nostalgia, in turn, will have a positive influence on one's current state. By so doing, the emotion functions as a balancing feedback mechanism that maintains homeostasis.

The regulatory model rests on a strong empirical foundation. For example, Wildschut et al. (2006) examined nostalgia's regulatory role in relation to the negative

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[1] Turner and Stanley (2021) reported that, among older participants, increases in negative affect were associated with a ninefold increase in nostalgia (relative to non-nostalgia) likelihood (odds ratio = 9.34). Odds ratios are difficult to interpret, because they are ratios of ratios. Whereas this finding might suggest that, among older adults, nostalgic events were predominantly associated with negative affect, this was not the case. On a 5-point scale, older adults reported more positive affect ($M = 2.48$, $SD = 0.77$) than negative affect ($M = 1.22$, $SD = 0.37$) for daily nostalgic experiences (J. R. Turner, personal communication, August 9, 2022).

psychological state of loneliness (see also Abeyta et al., 2015a; Zhou et al., 2008, 2022). They demonstrated that high (compared to low) loneliness, successfully induced via false feedback, triggered nostalgia (Study 4). In turn, nostalgia, induced via vivid autobiographical recall, increased social connectedness (e.g., “loved,” “connected to loved ones”; Study 5), secure attachment (Study 6), and interpersonal competence (Study 7). Van Tilburg et al. (2018) tested the regulatory model in relation to negative environmental conditions, specifically adverse weather (see also Zhou et al., 2012, Study 1). They randomly assigned participants to listen to a recording of light breeze (control) or recordings of adverse weather (heavy wind, heavy thunder, or heavy rain). Adverse-weather recordings (compared to control) triggered nostalgia (Study 1). Weather-induced nostalgia, in turn, conveyed psychological benefits (Study 4).

Spatial Anxiety and Nostalgia

The key objective of the current research was to test the regulatory model in relation to spatial anxiety, that is, discomforting apprehension and disorientation during navigation (Lyons et al., 2018; Malanchini et al., 2017). Environmental navigation is an essential multisensory skill (Golledge, 1999; Gramann et al., 2006). Successful navigation allows one to reach desired places, source food, socialize, and explore as well as achieve a sense of well-being and equanimity. By contrast, losing one’s bearings can trigger distress and confusion (Lynch, 1960; Carlson et al., 2010). Spatial anxiety undermines one’s confidence in their navigational ability, resulting in impaired navigation performance (Hund & Minarik, 2006; Walkowiak et al., 2015).

We tested the regulatory model in two steps, implementing an experiment-causal-chain strategy (Spencer et al., 2005). First, we tested the effect of spatial anxiety on nostalgia. In Experiment 3.1, we induced spatial anxiety by training participants to navigate a route in a virtual maze and then surreptitiously changing part of the previously learned route (spatial-anxiety condition) or leaving the route unchanged (control condition). We hypothesized that spatial anxiety (compared to the control) would trigger nostalgia (H1). Second, we tested the effect of nostalgia on spatial anxiety. In Experiments 3.2-3, we displayed nostalgic (nostalgia condition) or matched control (control condition) pictures in a virtual maze. Participants navigated the maze passively (video clip, Experiment 3.2) or actively (computer-based task, Experiment 3.3). We hypothesized that nostalgia (compared to control) would reduce spatial anxiety (H2). In addition, Experiment 3.3 tested the supplemental hypothesis that nostalgia-induced reductions in spatial anxiety would have beneficial downstream consequences in terms of higher goal setting in the navigational domain (H3). We received ethical approval from the first author's institution. We report all measures and follow journal article reporting standards (Kazak, 2018). We did not preregister the experiments. The data and analysis scripts are available on OSF (https://osf.io/et7az/).

3.2 Experiment 3.1

In Experiment 3.1, we tested the effect of spatial anxiety on nostalgia. We used a validated task to manipulate spatial anxiety in the context of a virtual maze (Oliver et al., 2022). Virtual environments offer an effective methodological tool to simulate real-world settings, thus strengthening external validity (Lingwood et al., 2015; Rudde et al., 1997, Walkowiak et al., 2015). The flexibility in design allows elements of the environment to be controlled and displayed from a 3D first-person perspective (Richardson et al., 1999). We first trained participants to navigate a route within the maze and then surreptitiously changed part of the previously learned route (spatial-anxiety condition) or left the route unchanged (control condition). We hypothesized that participants in the spatial-anxiety condition would feel more nostalgic than those in the control condition (H1).

3.2.1 Method

3.2.1.1 Participants and Design

Sixty-four University of Southampton undergraduate students (39 women, 25 men) took part in a 40-minute experiment in return for course credit. Participants' age ranged from 18 to 49 years (M = 20.64, SD = 4.95). We randomly assigned participants to either the spatial-anxiety (n = 32) or control (n = 32) condition. We based the sample size on an a priori power analysis. Our effect-size estimate was informed by an experiment testing the effect of negative mood (an aversive psychological state) on nostalgia (Wildschut et al., 2006, Experiment 3). That experiment was informative, because it assessed nostalgia with the same two measures that we used in the current experiment (described below), yielding two estimates for the effect of negative mood on nostalgia. We conservatively predicated our power analysis on the smaller of these two effects (f = 0.36). Achieving 80% power to detect an effect of this magnitude requires 64 participants, given α = .05 (G*Power 3.1; Faul et al., 2007). We met this recruitment target.

3.2.1.2 Procedure and Materials

The experiment took place in a windowless research cubicle with a single desktop computer. The computer used a standard Windows 7 operating system and was placed on a 1.3m wide desk in the center of the rear wall. Three identical 15-inch LCD monitors were arranged so that images were shown continuously across all three screens. We developed three computer-generated mazes for this experiment, using 3DSMax 2012. The software program placed participants within a virtual environment and offered a first-person perspective. Participants could explore the virtual maze by using the "FORWARD," "BACKWARD," "LEFT," and "RIGHT" arrow keys, but could not look up or down, or interact with items within the environment. Pictures were placed on the walls of the maze at forced turns and junctions. The pictures comprised 2D colorful images of neutral content, such as an apple, tree, bus, or abstract patterns. Figure 2.1 displays the maze from participants' perspective.

Route-Learning Tasks. The experiment involved two route-learning tasks. The first task acquainted participants with the virtual maze and the second involved the manipulation of spatial anxiety (Oliver et al., 2022). Each route-learning task consisted of a training and test phase. In the training phase, participants followed arrows indicating a route through the maze. Once participants reached their destination, the trial terminated. In the test phase, the arrows were removed and participants were instructed to navigate the same route through the maze.

The first route-learning task consisted of five training trials with directional arrows present. The virtual maze for the first route-learning task involved 10 turns and displayed six pictures that acted as local landmarks (Figure 3.1). The training phase was followed by one test trial in which we removed the arrows. On this trial, the virtual maze contained walls that blocked alternative routes or shortcuts to prevent participants from diverging off the designated route.

The second route-learning task involved three training trials, in which arrows led participants through a new path in a virtual maze. The virtual maze for this second task involved 10 turns and displayed seven pictures that formed local landmarks (Figure 2.2). The three training trials were followed by a test trial, in which we removed the arrows and participants navigated the path they had learned in the training phase. In the control condition, we used the same maze in the training and test trials. In this condition, on the test trial, we blocked all alternative routes to ensure participants navigated the learned path. In the spatial-anxiety condition, however, we surreptitiously introduced changes to the maze (Figure 2.3). After the fifth turning point, this new maze presented a novel and more complex layout, which included four additional pictures and added paths. After the ninth turning point, the route returned to the original layout. If participants were unable to complete the test trial within 4 minutes, the experimenter guided them to the end destination.

3.2.1.3 Dependent Variables

Immediately after the second route-learning task, we assessed the following dependent variables.[2]

Manipulation Checks. We administered two manipulation checks to assess participants' momentary feelings of spatial anxiety. The first scale, which we constructed for the purposes of this experiment, comprised three items ("Right now, I feel a bit lost," "... I have the sense of being lost," "... I feel disoriented"), each rated on a 6-point scale (1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = .94$, $M = 2.86$, $SD = 1.46$). The second manipulation check was the 8-item Spatial Anxiety Scale (Lawton, 1994). Items described various spatial-navigation scenarios (e.g., "Finding your way around in an unfamiliar mall," "Trying a new route that you think will be a shortcut without the benefit of a map"), and participants rated how anxious each scenario would make them feel, using a 5-point rating scale (1 = *not at all anxious*, 5 = *very anxious*; $\alpha = .87$, $M = 2.80$, $SD = 0.86$). The two manipulation checks were significantly and positively correlated, $r(64) = .43$, $p < .001$.

Nostalgia. We assessed momentary nostalgia with two scales. First, we administered a state version of the Nostalgia Inventory (NI; Batcho, 1995). Participants rated how much they missed 18 persons, situations, or events from their past (e.g., "Family," "Places," "Holidays")[3] in the present moment, using a 6-point rating scale (1 = *I do not miss at all*, 6 = *I miss very much*; $\alpha = .86$, $M = 2.99$, $SD = 0.83$). Next, we

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[2] For exploratory purposes, we assessed a number of additional dependent variables (Appendix B.3).

[3] The original Batcho (1995) scale contained two additional items, "church/religion" and "heroes/heroines." Prior research (Wildschut et al., 2006) showed that these items manifested restriction of range as a result of extremely low ratings, perhaps because the items were inapplicable to British cultural context. In line with this prior research, we excluded the two items from present use.

administered a validated 3-item measure of state nostalgia (Wildschut et al., 2010). Items were: "Right now, I am feeling quite nostalgic," "Right now, I am having nostalgic feelings," and "I feel nostalgic at the moment" (1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = .95$, $M = 3.13$, $SD = 1.46$). The two nostalgia measures were significantly correlated, $r(64) = .65$, $p < .001$.

Affect. Prior research has demonstrated that negative affect triggers nostalgia (Wildschut et al., 2006). Could the spatial-anxiety induction increase negative affect and, by so doing, increase nostalgia? To find out, we assessed positive affect ("Right now, I feel happy," "Right now, I feel in a good mood") and negative affect ("Right now, I feel unhappy," "Right now, I feel sad") with two items each. We averaged the respective items to create positive affect ($\alpha = .95$, $M = 4.25$, $SD = 0.99$) and negative affect ($\alpha = .94$, $M = 2.15$, $SD = 1.09$) indices.

3.2.2 Results and Discussion

3.2.2.1 Manipulation Checks

As intended, participants in the spatial-anxiety condition ($M = 3.76$, $SD = 1.29$) scored higher on the 3-item measure of momentary spatial anxiety than those in the control condition ($M = 1.97$, $SD = 1.00$), $F(1, 62) = 38.46$, $p < .001$, $f = 0.77$. Participants in the spatial-anxiety condition ($M = 3.05$, $SD = 0.92$) also scored higher on the 8-item Spatial Anxiety Scale than those in the control condition ($M = 2.54$, $SD = 0.71$), $F(1, 62) = 6.17$, $p = .016$, $f = 0.28$. The spatial-anxiety manipulation was effective.

3.2.2.2 Nostalgia

Participants in the spatial-anxiety condition ($M = 3.20$, $SD = 0.67$) felt significantly more nostalgic for persons, situations, or events from their past (as assessed by the NI) than those in the control condition ($M = 2.78$, $SD = 0.93$), $F(1, 62) = 4.21$, $p = .044$, $f = 0.22$. Participants in the spatial-anxiety condition ($M = 3.63$, $SD = 1.27$) also felt more momentary nostalgia (as assessed by the 3-item scale) than those in the control condition ($M = 2.64$, $SD = 1.48$), $F(1, 62) = 8.25$, $p = .006$, $f = 0.34$.

The spatial-anxiety and control conditions did not differ significantly on positive affect ($M_{\text{spatial anxiety}} = 4.17$, $SD = 0.99$ vs. $M_{\text{control}} = 4.33$, $SD = 1.00$; $F[1, 62] = 0.40$, $p = .531$, $f = 0.00$) or negative affect ($M_{\text{spatial anxiety}} = 2.19$, $SD = 1.11$ vs. $M_{\text{control}} = 2.11$, $SD = 1.09$; $F[1, 62] = 0.08$, $p = .777$, $f = 0.00$). The effect of spatial anxiety on nostalgia remained significant when controlling simultaneously for positive affect and negative affect: for the NI, $F(1, 61) = 4.46$, $p = .039$, $f = 0.23$; for the 3-item nostalgia measure, $F(1, 61) = 8.04$, $p = .006$, $f = 0.33$. Thus, the spatial-anxiety induction specifically increased spatial anxiety but did not increase general negative affect (or decrease general positive affect). Neither negative affect nor positive affect accounted for the effect of spatial anxiety on nostalgia.

Spatial anxiety (compared to control) augmented nostalgia, supporting H1. This finding is consistent with the regulatory model of nostalgia, which proposes that aversive states trigger nostalgia. The regulatory model further posits that nostalgia, in turn, counteracts these aversive states. In the present context, this entails that nostalgia will reduce spatial anxiety (H2). We tested this hypothesis next, by directly manipulating nostalgia within a virtual maze.

3.3 Experiment 3.2

In Experiment 3.2, we examined the effect of nostalgia on spatial anxiety. Participants watched a video recording from a first-person perspective, moving through a virtual maze. On the walls of the maze, we displayed either nostalgic (nostalgia condition) or matched control (control condition) pictures. We hypothesized that participants in the nostalgia condition would experience less spatial anxiety than those in the control condition (H2).

3.3.1 Method

3.3.1.1 Participants and Design

Two hundred and thirty-one visitors (196 women, 40 men) attended a series of six open days at the University of Southampton. At each session, we recorded participants' age range according to three categories: 18-24 years (n = 196), 25-30 years (n = 16), 30 years or above (n = 19).[4] Participants completed the 30-minute experiment as part of an introduction to psychological research. We randomly assigned them to the nostalgia (n = 108) or control (n = 123) condition. Power analysis was complicated by two factors. First, although Experiment 3.1 examined a new independent variable (spatial anxiety), we could turn to a prior study that implemented the same dependent variables (measures of nostalgia) to inform our effect size estimate. In the current experiment (and Experiment 3.3), however, both the independent variable (pictorial induction of nostalgia) and dependent variable (spatial anxiety) were new. Hence, we were in the dark with respect to the anticipated effect size. Second, we had no control over the number of visitors who would attend the open days and therefore were unable to plan the number of participants a priori. We decided to recruit as many visitors as possible, and stipulated that the final sample size should afford at least 80% power to detect a medium-sized effect (f = 0.25; α = .05). These parameters yielded a minimum sample size of 128, which we exceeded. A sensitivity power analysis revealed that the achieved sample size (N = 231) afforded at least 80% power to detect effects equal to or greater than f = 0.19 (G*Power 3.1; Faul et al., 2007).

3.3.1.2 Procedure and Materials

Participants completed two route-learning tasks involving exploration of a virtual maze.

[4] Institutional requirements prohibited the recording of individual ages.

Route-Learning Tasks. The first route-learning task served to acquaint participants with a virtual maze (Figure 3.2). The experimenter instructed participants to watch a video clip of a navigation through a virtual maze from a first-person perspective. The clip lasted approximately 45 seconds and a series of directional arrows guided the viewer along a specified route. The walls of the maze displayed 10 colorful pictures with neutral content (e.g., apple; Figure 3.3). The experimenter instructed participants to remember the pictures shown along the route, as well as which direction to take at each picture.

The second route-learning task provided the context for the experimental manipulation of nostalgia. The second task started with a training phase, in which participants viewed a second video clip of a navigation through a virtual maze. This second maze was longer and featured more turns than the one in the first route-learning task (Figure 3.4). The video recording lasted approximately 60 seconds. The maze contained 21 pictures, 11 of which were colorful depictions of neutral objects. The remaining 10 were either nostalgic (nostalgia condition) or matched control (control condition) pictures. Images included characters from TV series (e.g., Doctor Who) and films (e.g., Harry Potter), as well as artists (e.g., Justin Bieber). In the nostalgia condition, the 10 pictures displayed content dating back five years or more. In the control condition, the 10 pictures displayed the present-day counterparts of the images in the nostalgia condition. For example, one of the images in the nostalgia condition depicted Emma Watson as the character Hermione Grainger in *Harry Potter and the Philosopher's Stone* (Watts et al., 2020). In the control condition, the corresponding image depicted Emma Watson at the time of the experiment (Figure 3.3).

3.3.1.3 Dependent Variables

After watching the second clip, participants completed the dependent variables. Given that participants were attending a university open day and received no compensation, we used brief, single-item measures. They responded to a manipulation check ("Right now, I feel nostalgic"; $M = 2.57$, $SD = 1.42$) and rated their spatial anxiety in the maze ("I felt lost when I was in the mazes"; $M = 3.30$, $SD = 1.62$). Each item was rated on a 6-point scale (1 = *strongly disagree*, 6 = *strongly agree*). A debriefing concluded the experiment.

3.3.2 Results and Discussion

Participants in the nostalgia condition ($M = 2.78$, $SD = 1.41$) felt significantly more nostalgic than those in the control condition ($M = 2.39$, $SD = 1.40$), $F(1, 229) = 4.38$, $p = .038$, $f = 0.12$. The nostalgia manipulation was effective. Consistent with the regulatory model, participants in the nostalgia condition ($M = 3.01$, $SD = 1.53$) experienced significantly less spatial anxiety than those in the control condition ($M = 3.56$, $SD = 1.65$), $F(1, 229) = 6.87$, $p = .009$, $f = 0.16$. Nostalgia reduced spatial anxiety, supporting H2.

For the first time, we created a successful pictorial nostalgia manipulation within a virtual spatial environment. Passive exposure to a virtual environment with nostalgic (compared to control) pictures increased nostalgia and reduced spatial anxiety. Yet, Experiment 3.2 had several limitations. First, it involved a passive navigation task, in which participants viewed video recordings rather than actively navigating the maze. Second, we assessed felt nostalgia (i.e., manipulation check) and feelings of being lost with single items only. Third, we did not assess downstream consequences of nostalgia-induced reductions in spatial anxiety. Might nostalgia, by virtue of its beneficial effect on (reduced) spatial anxiety, promote higher goal setting in the navigational domain? We addressed these issues in Experiment 3.3 by manipulating nostalgia in an active navigation task, assessing outcome variables with multi-item measures, and examining goal setting as a downstream consequence of reduced spatial anxiety.

3.4 Experiment 3.3

In Experiment 3.3, we examined the effect of nostalgia on spatial anxiety in an active navigation task. We used the same pictorial nostalgia manipulation as in Experiment 3.2 and hypothesized that participants in the nostalgia condition would experience less spatial anxiety than those in the control condition (H2). Further, we hypothesized that nostalgia-induced reductions in spatial anxiety would have beneficial downstream consequences for goal setting in the navigational domain. The expectancy-value perspective on goal setting (Campbell, 1982; Levy & Baumgardner, 1991; Lewin et al., 1944) maintains that goal choice is a function of one's perceived ability to achieve the goal and the value one assigns to the goal. If nostalgia sooths spatial anxiety, it should increase one's perceived ability to complete a challenging navigation task and thus result in higher goal setting in this domain. We assessed goal setting by offering participants a choice between performing an easy or hard additional navigation task (participants did not actually perform this future task).

For exploratory purposes, we introduced an additional independent variable: maze difficulty. Some prior research has suggested that beneficial effects of nostalgia can be pronounced under challenging circumstances (Sedikides et al., 2015; Van Dijke et al., 2019). Accordingly, we explored if nostalgia would reduce spatial anxiety more in a difficult (than easy) maze.

3.4.1 Method

3.4.1.1 Participants and Design

One hundred and twenty University of Southampton undergraduate students (100 women, 19 men, one who did not respond to demographic questions) took part in the 30-minute experiment for course credit. Participants' age ranged from 17 to 39 years (M = 19.40, SD = 2.32). We conducted a power analysis for a 2 (nostalgia vs. control) × 2 (easy maze vs. difficult maze) between-subjects design using G*Power 3.1 (Faul et al., 2007). We specified a medium effect size, as in Experiment 3.2 ($f = 0.25$). The power analysis yielded a sample size requirement of 128 to achieve 80% power ($\alpha = .05$). We fell slightly short of this target and achieved a sample size of 120. A sensitivity power analysis revealed that this afforded at least 80% power to detect effects equal to or greater than $f = 0.26$ (G*Power 3.1; Faul et al., 2007). We randomly assigned participants to the conditions (cell *n*s = 30).

3.4.1.2 Procedure and Materials

We used the same equipment as in Experiment 3.1. The first route-learning task served to acquaint participants with the virtual maze. The second route-learning task provided the context for the experimental manipulation of nostalgia and maze difficulty. It was followed by the dependent measures and a debriefing.

First Route-Learning Task. The first route-learning task consisted of five training trials, on which directional arrows were present. The maze included 10 neutral pictures and eight turning points (Figure 3.5). The training phase was followed by a test trial, on which the directional arrows were absent.

Second Route-Learning Task. For the second route-learning task, participants completed three training trials with directional arrows and one test trial without directional arrows. We created four virtual mazes that differed in terms of pictorial content and maze difficulty, corresponding to the four cells of the 2 (nostalgia vs. control) × 2 (difficult maze vs. easy maze) design. The easy maze contained neutral pictures at each of three decision-making points, and four nostalgic/matched control pictures at the each of the forced turning points. There were a further six nostalgic/matched control pictures within the maze, one positioned at the starting point, three along straight passageways, and two on off-route paths (Figure 3.6). The difficult maze contained neutral pictures at each of 11 decision-making points, and nostalgic/matched control pictures at three decision-making points and four forced turning points. There were three more nostalgic/matched control pictures within the maze, one located along a straight passageway and two on off-route paths (Figure 3.7).

3.4.1.3 Dependent Variables

After the second route-learning task, we assessed the following dependent variables.[5]

Manipulation Check. We administered a validated 3-item measure to assess state nostalgia (Wildschut et al., 2010). Items were: "Right now, I am feeling quite nostalgic," "Right now, I am having nostalgic feelings," and "I feel nostalgic at the moment" (1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = .92$, $M = 2.97$, $SD = 1.26$).

Spatial Anxiety. Participants rated how spatially anxious they felt during the navigation task on two scales. The first was a face-valid, 4-item measure that we created: "During the navigation task, I felt lost," "... disoriented," "... adrift," and "... like going around in circles" (1 = *strongly disagree*, 6 = *strongly agree;* $\alpha = .90$, $M = 2.44$, $SD = 1.24$). The second scale was the spatial anxiety scale, as in Experiment 3.1 (1 = *not at all anxious*, 5 = *very anxious*; $\alpha = .87$, $M = 2.84$, $SD = 0.84$). The two measures were significantly and positively correlated, $r(119) = .35$, $p < .001$.

Goal Setting. We asked participants if they would like to complete an "*easy*" (coded 0) or "*hard*" (coded 1) navigation task in the future. This question served as our measure of goal setting ($M = .63$, $SD = .04$).

Picture Recall. To address the possibility that the nostalgic pictures (e.g., Emma Watson as the character Hermione Grainger) were more recognizable or memorable than the control ones (e.g., Emma Watson at the time of the experiment), we instructed

[5] We measured additional variables for exploratory purposes (Appendix B.3).

participants to describe the pictures they saw during the navigation task. We focused on the number of correctly recalled nostalgic/matched control pictures ($M = 4.62$, $SD = 1.65$). We disregarded recall of the neutral pictures, which were identical in the nostalgia and control conditions (there was no significant recall difference between conditions).

3.4.2 Results

Unless otherwise specified, we entered the dependent variables in a 2 (nostalgia vs. control) × 2 (difficult maze vs. easy maze) Analysis of Variance. We present means and standard deviations in Table 3.1. Degrees of freedom vary due to missing values.

3.4.2.1 Manipulation Check

Analysis of the manipulation check (i.e., felt nostalgia) revealed a significant main effect of nostalgia, $F(1, 116) = 8.91$, $p = .004$, $f = 0.26$. As intended, participants in the nostalgia condition felt more nostalgic than those in the control condition. The main effect of maze difficulty was not significant, $F(1, 116) = 1.94$, $p = .166$, $f = 0.09$. The interaction effect was not significant either, $F(1, 116) = 0.00$, $p = 1.00$, $f = 0.00$. The pictorial nostalgia manipulation was again effective.

3.4.2.2 Spatial Anxiety

For the first, 4-item measure of spatial anxiety, results revealed a significant nostalgia main effect, $F(1, 116) = 3.94$, $p = .049$, $f = 0.16$. Supporting H2 and conceptually replicating Experiment 3.2 findings, participants in the nostalgia condition felt less spatially anxious than those in the control condition. Neither the main effect of maze difficulty, $F(1, 116) = 0.97$, $p = .327$, $f = 0.00$, nor the interaction effect, $F(1, 116) = 0.25$, $p = .617$, $f = .00$, was significant.

Analysis of the spatial anxiety scale also revealed a significant nostalgia main effect, $F(1, 115) = 6.20$, $p = .014$, $f = 0.21$. Further supporting H2, participants in the nostalgia condition again reported lower spatial anxiety than those in the control condition.

The main effect of maze difficulty was significant as well, indicating that participants reported more spatial anxiety after navigating the difficult (than easy) maze, $F(1, 115) = 4.08$, $p = .046$, $f = 0.16$. The interaction effect was trending, $F(1, 115) = 3.71$, $p = .057$, $f = 0.15$, indicating that the effect of nostalgia (vs. control) on spatial anxiety was numerically (but not significantly) larger in the difficult than easy maze.

3.4.2.3 Goal Setting

Participants indicated whether they would prefer to complete an easy or hard navigation task in the future. We entered their binary responses as dependent variable in a 2 (nostalgia vs. control) × 2 (difficult maze vs. easy maze) logistic regression analysis. The proportion of participants who preferred a difficult future task was significantly higher in the nostalgia condition (43:59 = .73) than in the control condition (32:60 = .53), $\chi^2(1, N = 119) = 4.66$, $p = .031$, $b^* = .24$. The effect of maze difficulty was not significant, $\chi^2(1, N = 119) = 2.32$, $p = .128$, $b^* = -.17$, nor was the interaction effect, $\chi^2(1, N = 119) = 0.29$, $p = .592$, $b^* = .06$.

3.4.2.4 Mediation of Nostalgia's Effect on Goal Setting by Reduced Spatial Anxiety

We next tested whether the beneficial effect of nostalgia on goal setting was mediated by reduced spatial anxiety (H3). We carried out separate mediation analyses for each of our spatial anxiety measures, using PROCESS macro (Hayes, 2022). The analysis with the 4-item measure of spatial anxiety as mediator revealed a significant indirect effect (*ab*) of nostalgia (compared to control) on higher goal setting via reduced spatial anxiety, $ab = 0.12$, $SE = 0.08$, 95% CI = [0.001, 0.318]. The analysis with the spatial anxiety scale as mediator also revealed a significant indirect effect, $ab = 0.17$, $SE = 0.10$, 95% CI = [0.028, 0.408]. Reduced spatial anxiety mediated the effect of nostalgia on higher goal setting in the navigation domain.

3.4.2.5 Moderated Mediation Analyses

We ran moderated mediation analyses (PROCESS macro, Model 7, 5,000 bootstraps; Hayes, 2022) to test whether maze difficulty (difficult maze vs. easy maze) moderated the indirect effect of nostalgia on goal setting through reduced spatial anxiety. We carried out separate moderated mediation analyses for each of our spatial anxiety measures. The index of moderated mediation was not significant with either the 4-item measure of spatial anxiety as a mediator, index = 0.13, SE = 0.27, 95% CI = [−0.369, 0.708] or the spatial anxiety scale as a mediator, index = 0.54, SE = 0.36, 95% CI = [−0.023, 1.383].

3.4.2.6 Picture Recall

Finally, we examined the number of nostalgic/matched control pictures that participants recalled. Given that these were count data, we fit a generalized linear model, specifying a Poisson probability distribution. The difficult and easy maze included the same number of nostalgic/matched control pictures. We therefore did not expect a significant main effect of maze difficulty, and there was none, $\chi^2(1, N = 119) = 0.50$, $p = .479$. Further, neither the main effect of nostalgia, $\chi^2(1, N = 119) = 0.13$, $p = .716$, nor the interaction effect, $\chi^2(1, N = 119) = 0.20$, $p = .652$, was significant. Thus, there was no indication that the nostalgic pictures were more recognizable or memorable than the matched control ones.

3.4.3 Discussion

Consistent with the regulatory model and further corroborating H2, participants in the nostalgia condition felt less spatially anxious than those in the control condition. Further, participants in the nostalgia (compared to control) condition were more willing to take on a difficult (vs. easy) future spatial task. Mediation analyses revealed that this effect of nostalgia on higher goal setting in the navigation domain was mediated by reduced spatial anxiety (both measures), supporting H3. Commitment to specific, challenging goals is a robust predictor of future performance (Locke et al., 1981), raising the prospect of further beneficial downstream consequences of nostalgia in a navigational context.

We acknowledge that mediator, spatial anxiety, was measured rather than manipulated and, hence, the mediation analyses did not establish causality (Fiedler et al., 2018). Nonetheless, the results are informative because they placed the hypothesis that spatial anxiety would mediate the beneficial effect of nostalgia on goal setting at risk (Fiedler et al., 2011). Results did not support a moderating role of maze difficulty. A possible explanation is that the maze-difficulty manipulation lacked strength. The main effect of maze difficulty on spatial anxiety (which could be regarded as a manipulation check) was statistically significant for only one of the two spatial anxiety measures. Future research could address this by implementing a stronger maze-difficulty manipulation.

3.5 General Discussion

Spatial anxiety entails distress and confusion, and erodes one's navigational confidence and performance (Lynch, 1960; Hund & Minarik, 2006; Walkowiak et al., 2015). It is crucial, then, to identify effective strategies to reduce spatial anxiety. According to the regulatory model of nostalgia, the emotion helps to maintain equanimity when confronting adverse psychological and environmental conditions (Sedikides et al., 2015; Wildschut & Sedikides, 2022, in press). In three experiments, we tested the regulatory model in relation to spatial anxiety.

Specifically, we hypothesized that spatial anxiety would trigger nostalgia (H1) and that nostalgia, in turn, would assuage spatial anxiety (H2). We evaluated these hypotheses in two steps, following an experiment-causal-chain strategy (Spencer et al., 2005). First, in Experiment 3.1, a validated spatial-anxiety induction (Oliver et al., 2022) increased nostalgia, supporting H1. Second, a novel, pictorial nostalgia induction reduced spatial anxiety in passive (Experiment 3.2) and active (Experiment 3.3) navigation tasks, substantiating H2. Pointing to the emotion's downstream benefits, nostalgia-induced reductions in spatial anxiety were associated with higher goal setting in the navigational domain (H3; Experiment 3.3).

3.5.1 Implications

Our findings have theoretical, methodological, and applied implications. On a theoretical level, we extend the reach of the regulatory model. Nostalgia is known to assuage various discomforting intrapersonal states, such as disillusionment (by increasing meaning in life; Maher et al., 2021) and loneliness (by increasing a sense of social connectedness, secure attachment, and interpersonal competence; Wildschut et al., 2006). Other studies have demonstrated that the emotion can help to maintain comfort following exposure to aversive environmental conditions, such as cold temperature (by increasing subjective warmth; Zhou et al., 2012) and inclement, stormy weather (by reducing weather-induced distress; Van Tilburg et al., 2018). Here, we focused on a qualitatively different type of environmental threat: spatial anxiety—an aversive state that arises when becoming disoriented and lost in an otherwise benign physical environment. The threat, then, does not arise from the environment per se, but from one's actual or perceived inability to master it. Follow-up research could address the utility of the regulatory model with respect to other impairments that could erode environmental mastery—for example to vision or hearing.

As for our methodological contribution, we presented a novel and effective pictorial nostalgia induction. The ERT (Sedikides et al., 2015; Wildschut et al., 2006) is the most frequently used nostalgia induction technique. It involves vivid autobiographical recall—a particularly effective procedure for eliciting emotions where high personal relevance is central to the affective experience (Joseph et al., 2020). Specifically, participants in the nostalgia condition are instructed to recall their most nostalgic experience, and participants in the control condition are instructed to recall an ordinary event from their past. Critics of the ERT have alleged that, because participants recall their most nostalgic experience, the task “selectively privileges” positive aspects of the emotion (Newman et al., 2020, p. 342). We are not aware of evidence to support this claim but ample to contradict it. For example, meta-analyses revealed that the ERT nostalgia induction increases both positive *and* negative affect (Frankenbach et al., 2021; Leunissen et al., 2021), and in an ERT experiment where participants were simply instructed to recall a typical (rather than their most) nostalgic experience, nostalgia still increased happiness and positive affect (Zhou et al., 2022). Notwithstanding, we agree that methodological diversity is a prerequisite for valid causal inferences and, indeed, researchers have developed a variety of nostalgia inductions to meet this objective, including ones based on music (Cheung et al., 2013, Study 3), song lyrics (Cheung et al., 2013, Study 4), photographs (Yang et al., 2021), and prototype features (Hepper et al., 2012). Our novel nostalgia induction within an interactive, life-like virtual environment expands this methodological arsenal.

From an applied perspective, the ability to successfully navigate one’s spatial environment is essential for everyday independent functioning and social interaction. Losing this ability can have serious negative consequences, as seen in individuals with neurological conditions, such as AD, epilepsy, stroke, and topographical disorientation disorders (Barrett & Muzaffar, 2014; Cimadevilla et al., 2014; Iaria & Barton, 2010; Monacelli et al., 2003). People living with dementia, for example, are more likely to become spatially disoriented and lost during their regular day-to-day activities—a distressing experience that can further reduce confidence in exploring environments and limit autonomy (Chiu et al., 2004; Tu & Pai, 2006). Therefore, it is important to consider ways to support individuals and groups with wayfinding difficulties. Environmental design guidelines highlight the relevance of signage, landmarks, and furnishings to reduce spatial anxiety and facilitate wayfinding (O’Malley et al., 2017). Our findings indicate that incorporating nostalgic design elements, such as wall mounted pictures, within the physical environment can further this goal.

3.5.2 Limitations and Future Directions

The pictures we used focused on a particular theme (i.e., popular TV shows, popular music artists) that we expected to elicit the emotion in our predominantly young-adult samples; that is, we adopted a nomothetic approach to manipulating nostalgia (i.e., establishing general principles that apply to a particular cohort or group; Dimitriadou et al., 2019). Future studies could incorporate additional themes (e.g., natural scenes, childhood toys, modes of transport) or even adopt an idiographic approach by tailoring nostalgic pictures to each individual's unique autobiography such as using images of hometown landmarks or family holidays.

Virtual environments are interactive and life-like, boosting ecological validity (Hegarty et al., 2006; Richardson et al., 1999; Ruddle et al., 1997). However, future studies should examine if our findings can be generalized to more naturalistic virtual surroundings (e.g., indoor residences, outdoor urban landscapes; Davis et al., 2017) and real-world environments (Nolan et al., 2002).

3.5.3 Coda

We demonstrated the utility of the regulatory model of nostalgia for understanding how individuals maintain equanimity when experiencing spatial anxiety. Spatial anxiety, induced by surreptitiously changing a well-rehearsed route, triggered nostalgia. In turn, a novel, pictorial nostalgia induction reduced spatial anxiety. Our findings contribute to theory, diversify the methodological toolbox, and have application potential.

Table 3.1

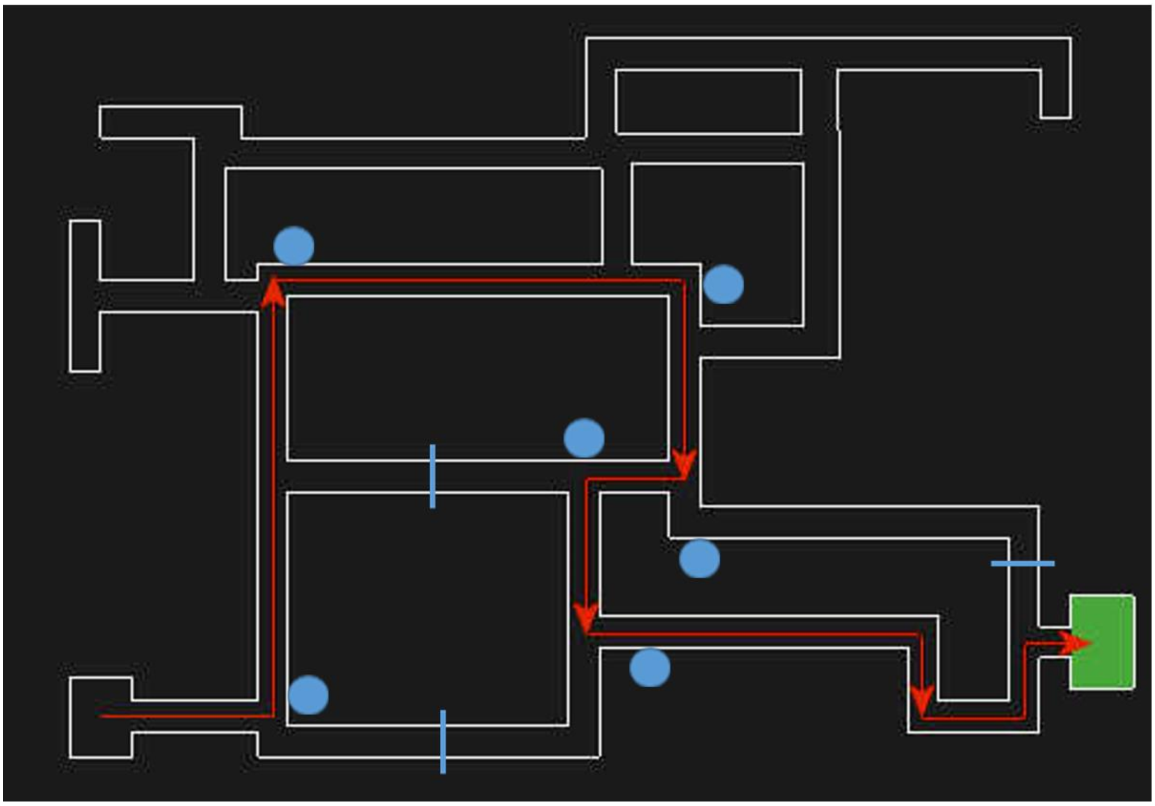
Means (Standard Deviations) as a Function of Nostalgia and Maze Difficulty in Experiment 3.3

	Control		Nostalgia	
	Easy maze	Difficult maze	Easy maze	Difficult maze
Felt nostalgia	2.48 (1.10)	2.79 (1.21)	3.14 (1.43)	3.46 (1.12)
Spatial anxiety (4 items)	2.49 (1.16)	2.83 (1.26)	2.16 (1.33)	2.27 (1.15)
Spatial anxiety scale	2.73 (0.69)	3.32 (1.01)	2.65 (0.70)	2.66 (0.78)
Goal setting	.63 (.09)	.43 (.09)	.77 (.08)	.69 (.09)
Picture recall	4.50 (1.70)	4.60 (1.35)	4.47 (1.63)	4.93 (1.93)

Note. Table entries for goal setting indicate the average proportion of participants selecting the difficult task within a given condition. We calculated the standard deviations of these proportions with the formula $\sqrt{pq/n}$. In our analysis, we specified a binomial probability distribution for these binary data. Table entries for picture recall indicate the average number of correctly recalled pictures within a given condition and, in our analysis, we specified a Poisson probability distribution for these count data.

Figure 3.1

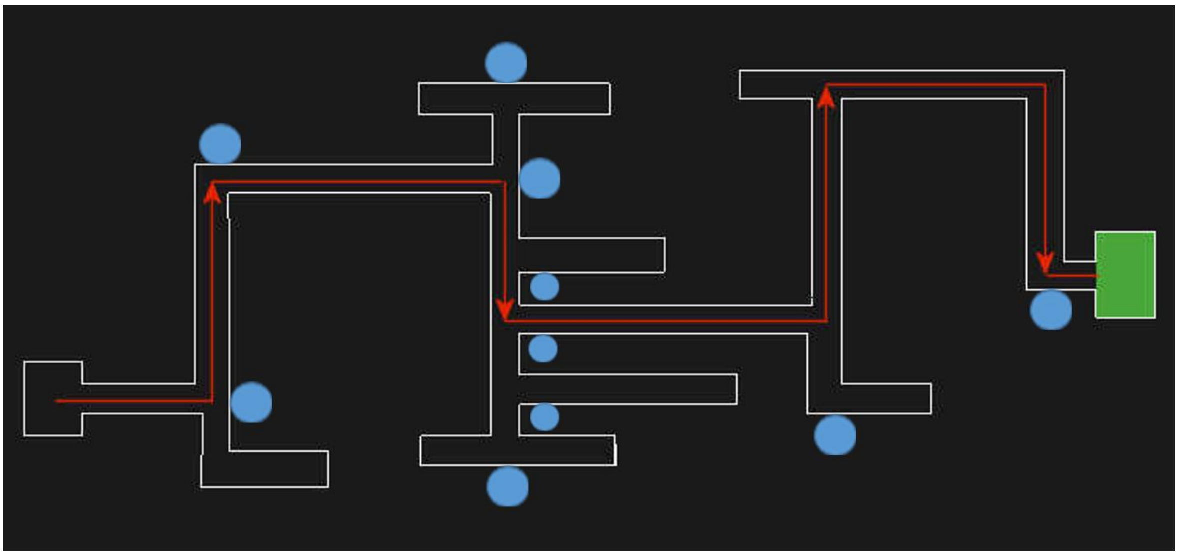
Maze Route for the First Route-Learning Task in Experiment 3.1



Note. Bird's eye view of the maze layout and route. The red arrows illustrate the specified route and the green box highlights the end destination. The blue circles highlight the position of the neutral pictures. The vertical lines indicate the location of the blocks introduced in the test trial.

Figure 3.2

Maze Route for the First Route-Learning Task in Experiment 3.2.



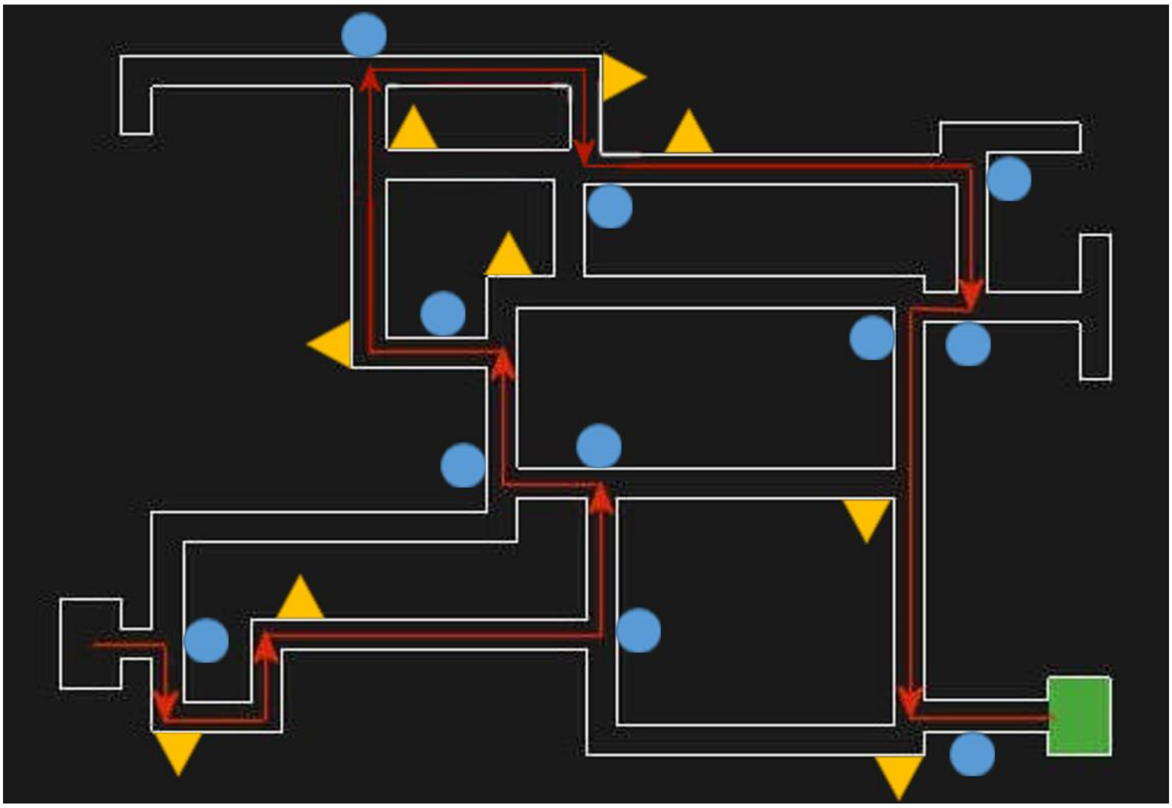
Note. Bird's eye view of the maze layout and route. The red arrows illustrate the specified route and the green box highlights the end destination. The blue circles highlight the position of the neutral pictures.

Figure 3.3

Examples of Neutral, Nostalgic, and Matched Non-Nostalgic Pictures in Experiment 3.2

Figure 3.4

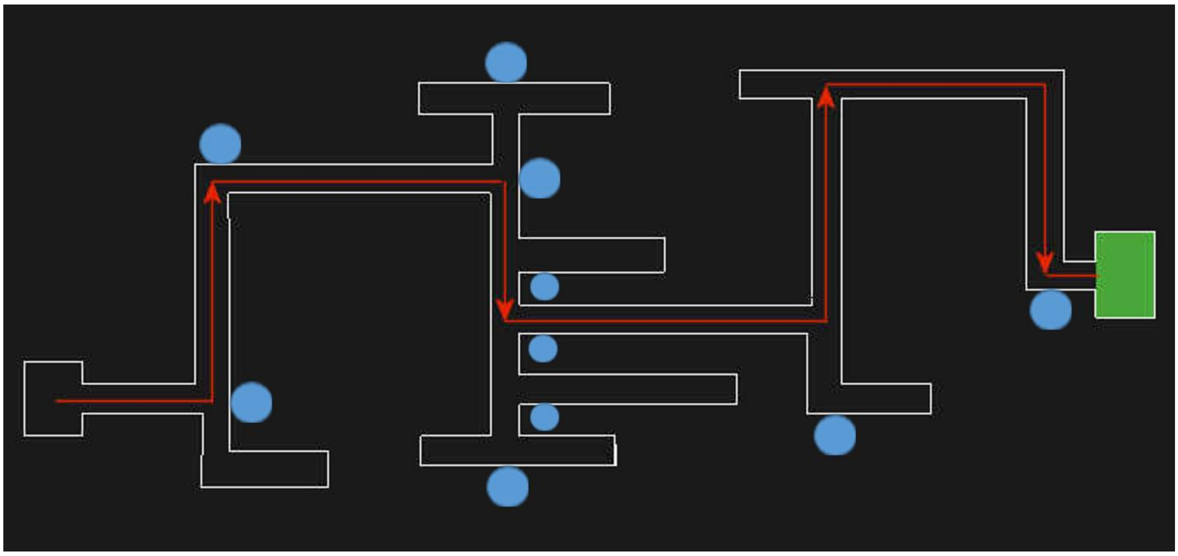
Maze Route for the Second Route-Learning Task in Experiment 3.2.



Note. Bird's eye view of the maze layout and route. The red arrows illustrate the specified route and the green box highlights the end destination. The blue circles highlight the position of the neutral pictures and the yellow triangles represent the position of the nostalgic or control pictures.

Figure 3.5

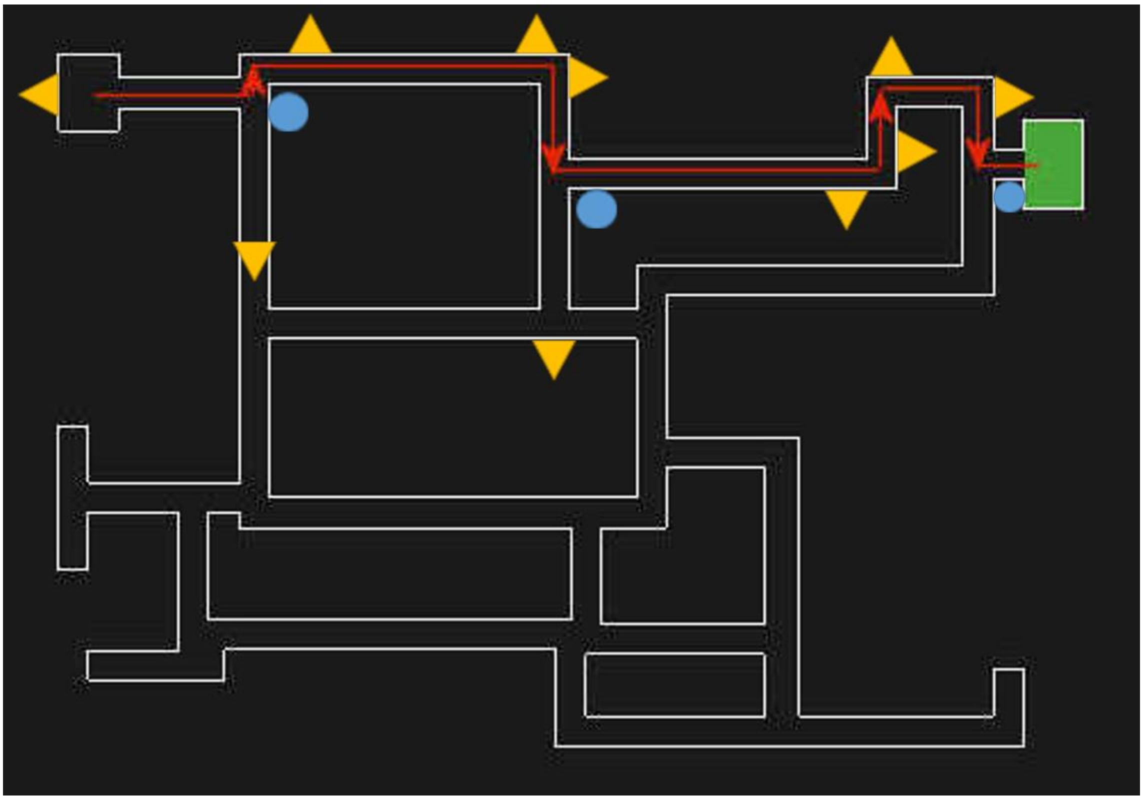
Maze Route for the First Route-Learning Task and Repeat-Test Trial in Experiment 3.3.



Note. Bird's eye view of the maze layout and route. The red arrows illustrate the specified route and the green box highlights the end destination. The blue circles highlight the position of the pictures.

Figure 3.6

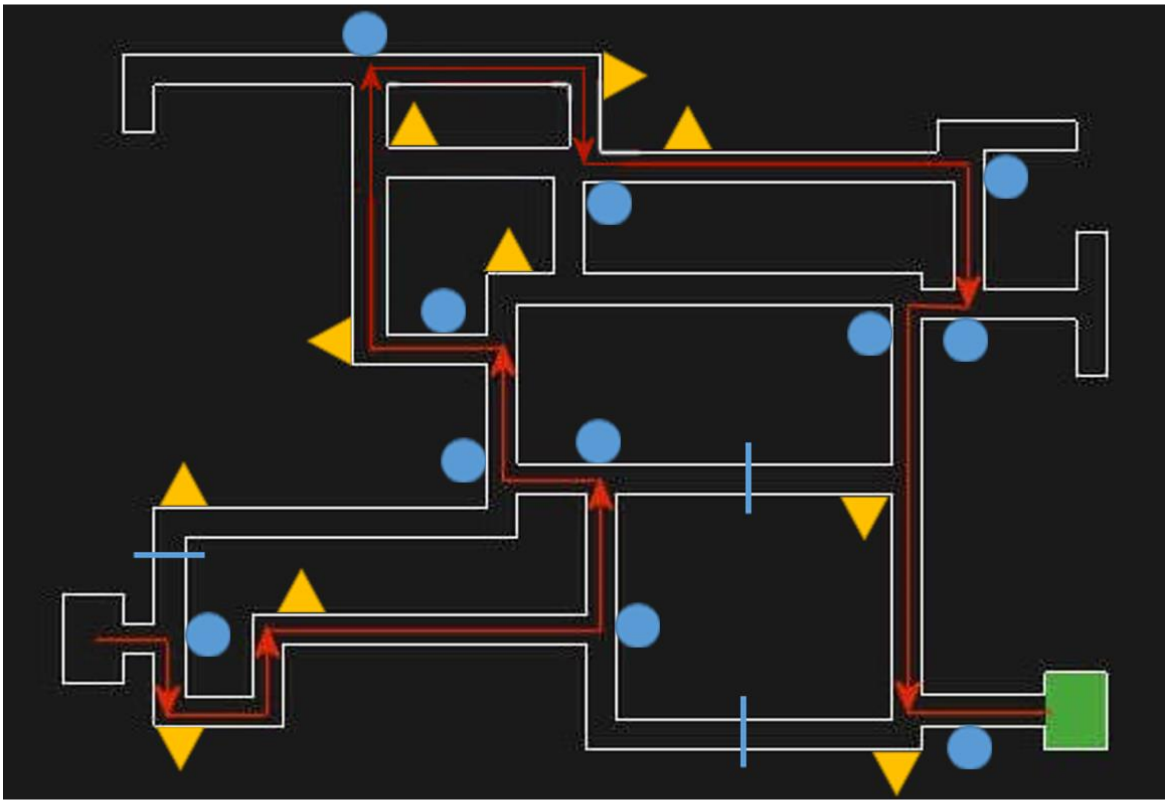
Maze Route for the Second Easy Route-Learning Task in Experiment 3.3.



Note. Bird's eye view perspective of the maze layout and route. The red arrows illustrate the specified route and the green box highlights the end destination. The blue circles highlight the position of the neutral pictures and the yellow triangles represent the position of the nostalgic or control pictures.

Figure 3.7

Maze Route for the Second Difficult Route-Learning Task in Experiment 3.3.



Note. Bird's eye view of the maze layout and route. The red arrows illustrate the specified route and the green box highlights the end destination. The blue circles highlight the position of the neutral pictures and the yellow triangles represent the position of the nostalgic or control pictures. The vertical lines indicate the location of the blocks introduced in the test trial.

3.6 Commentary

Here, I provide further validation of the spatial-anxiety manipulation, increasing the sample size from 44 to 98. Experiment 3.1, essentially, replicated the spatial-anxiety manipulation in Chapter 2 and tested the first part of the regulatory model of nostalgia in Chapter 3. The validated spatial-anxiety manipulation triggered a fundamental emotion beyond the spatial navigation literature. In addition, I introduced my second key methodological contribution—a pictorial nostalgia induction set within a virtual environment. In a new spatial context, nostalgia presented beneficial psychological effects. Across three experiments, the causal chain approach laid a strong theoretical case for the regulatory model of nostalgia, as well as identified potential mediating mechanisms.

Diversifying valid induction procedures amplifies design possibilities, and in turn, can deepen our theoretical understanding between fundamental concepts. Like most experimental designs, each one has its shortcoming, but here the causal chain of experiments is possibly the closest we may get to understanding the regulatory function of nostalgia when faced with spatial adversity. Nostalgia, again, demonstrated an adaptive coping mechanism style at the intra-individual (rather than collective) level. The meat of my empirical paper sandwich rooted my theoretical viewpoint. Next, I sought to apply my work to a clinical setting in my third and final empirical chapter.

The applications of Chapter 3 (i.e., nostalgia-infused environments may support people with dementia) guided the direction of Chapter 4. Given the difficulties faced by people with AD during navigation, I designed a project that next would incorporate a relevant clinical group. Collaborator, Professor Richard Cheston, signposted our team to Memory Assessment & Research Centre (MARC), Moorgreen hospital, Southampton, UK. MARC is an internationally renowned research centre that specializes in the delivery of memory research and treatments. MARC work with research participants under the care of National Health Service (NHS) and are part of Southern Health NHS Foundation Trust. In the early design phase, I met with co-manager, Suzanne Dodge and co-director, Dr Brady McFarlane, to discuss our plan to investigate the potential benefits of nostalgia, when applied to a spatial environment, for people living with dementia. The MARC team became our study site and supported us throughout the project. Working alongside the MARC team marked the beginning of my clinical research journey. In health-care settings, Patient and Public Involvement (PPI) is key to the development of research. That is, patients and the public are actively involved in the design, conduct or management of research studies. I did this by integrating the thoughts and views of laypeople, with and without experience of dementia, to improve my research methodology.

I conducted PPI work in two phases. In the first phase of my PPI work, I organized an event with older adults who were part of the Senior Saints activity program, Southampton, UK. I created a booklet filled with pictures dated from 1940 to 1960 of old cars, comedians, fashion icons, films, politicians, and sports heroes. I gathered the groups' feedback on the pictures. Like in Experiments 3.2 and 3.3, I implemented a nomothetic approach and selected pictures that were based on general principles that apply to a particular group. Most the individuals' at the event recognized the pictures but I observed a distinct response between a picture they recognized and a picture they recognized but was also associated with a meaningful memory. One individual, for example, pointed at an old car from the booklet that was owned by their father when they were young. The pictures associated with a loved one specific to their past triggered nostalgia more effectively. I observed how a nomothetic approach could lack the personal component of nostalgia. I needed to hear their story to transport them back to *their* past. This feedback directed my transition from a nomothetic approach and towards an idiographic one.

Other induction procedures (e.g., ERT, music, Cheung et al., 2013; Sedikides et al., 2015; Wildschut et al., 2006) typically elicit higher levels of felt nostalgia. In these procedures, participants' have the opportunity to draw from their unique past experiences (e.g., in a reflective writing exercise; Sedikides et al., 2015; Wildschut et al., 2006) or record a favourite song from their past (Cheung et al., 2013). In an idiographic approach, the procedure embodies the individuals' unique characteristics and autobiography. Interviews allow the individual to share personal moments and experiences from their past. I therefore chose to develop a set of interview questions that would unlock meaningful past memories and would provide content that could direct the nostalgic imagery selected in the induction procedure. In the second phase of my PPI work, I trialled the interview questions with four couples (one person with dementia and their partner). I first introduced the aim of the research study and purpose of the interview. Each couple suggested new questions (e.g., music at their wedding, band posters on their bedroom walls). One of the couples introduced a new theme on technology including helpful prompts e.g., type writer, tape drives, disk drives, thin strip Tipp-ex, vinyl record player, ole box TV, a brick phone, and telephone boxes. By the end, a forty-two question interview had formed (see Appendix C.6).

My clinical research project was midway through the NHS ethics process when the COVID-19 pandemic hit the UK. Understandably, COVID-19 research was a priority and research like mine took a back seat. The Health Research Authority continued to review doctoral research projects and my study received approval in July, 2020. Despite this, normal working life was at a standstill. For months, my project waited in the side-lines with no guarantee as to when or if it would start. A silver lining of the delay was time—extra time to run another study! My next chapter marks the culmination of my work, which I feel incredibly lucky to have completed during a challenging time in global history.

Chapter 4: Empirical Paper III

In this chapter, I examine the benefits of nostalgia, when applied to spatial environments, for middle-aged older adults and people living with AD. Impaired navigation, getting lost behaviour, and spatial anxiety feature early on in AD (Cushman et al., 2008; Davis & Veltkamp, 2020; DeIpolyi et al., 2007; Lithfous et al., 2013). The design of spaces, however, can assist with these challenges. Given that nostalgia-infused landmarks reduce spatial anxiety, in the following Chapter, I develop the pictorial nostalgia induction further to advance its clinical potential. With a healthy older-adult sample, I develop a more personalised nomothetic intervention, and then, adopt a highly personal idiographic intervention for individuals living with AD.

The paper that follows has been drafted and reviewed by myself and the second author. My contribution to the paper included obtaining University-based and NHS/HRA ethics approval (including PPI work), developing a dementia-friendly virtual environment, collecting and analysing the data, drafting the manuscript and incorporating feedback from other authors.

The Benefits of Nostalgic Landmarks for People With Alzheimer's disease

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Abstract

Emerging literature shows that nostalgia induced by event reflection and music boosts the psychological resources of people with dementia. Our objective was to test the potential benefits of nostalgic landmarks for people with AD within a spatial environment. We displayed the landmarks as wall-mounted pictures within a virtual interface. In Experiment 4.1, we developed the nostalgia manipulation by using pictures associated with the decade during which 173 healthy adults lived most of their childhood. In Experiment 4.2, we recruited 20 participants with early to moderate stage AD. We further personalised the nostalgic pictures by interviewing participants about their fond past memories, and generated images corresponding to these events. We hypothesized that navigating a virtual environment with wall-mounted nostalgic (compared to control) pictures would boost participants' psychological resources. The nostalgic pictures evoked higher levels of momentary nostalgia than did control pictures; the manipulation was successful (Experiments 4.1-2). Compared to control pictures, nostalgic pictures significantly increased self-reported social connectedness, self-continuity, meaning in life, self-esteem, and positive (but not negative) affect (Experiments 4.1-2). Participants in the nostalgia condition (compared to controls) evidenced better picture recognition but not improved spatial memory (Experiment 4.2). Our findings demonstrate that nostalgic landmarks boost psychological resources and enhance picture recognition among people with AD. This work has real-world applications for dementia friendly-design and therapy-related practices.

4.1 The Benefits of Nostalgic Landmarks for People With Alzheimer's Disease

For people living with AD, getting lost in everyday environments is common. At early stages of the disease, up to 55% of people experience difficulties with navigation (Chiu et al., 2004), especially when learning new routes (Cushman et al., 2008; Kavcic & Duffy, 2003; Rainville et al., 2001). Becoming lost can heighten spatial anxiety (Lawton, 1994; Lawton & Kallai, 2002), and reduce confidence in exploring unfamiliar places (Kaplan et al., 1998). Indoor environments in particular are often poorly designed, with similar looking hallways and long corridors (Passini, 1984; Passini et al., 2000). AD causes visual attention deficits (Rizzo et al., 2000), which affect a person's ability to attend to sensory information in their environment. To combat these challenges, environmental design guidelines recommend implementing recognisable and meaningful landmarks to support spatial navigation (Department of Health, 2015). Clinicians, researchers, and laypeople call for artwork or items that evoke positive emotions and are of personal relevance to a navigator (Department of Health, 2015; Kris & Henkel, 2019; O'Malley et al., 2018). Kris and Henkel (2019) highlight the importance of enriching environments for people with memory loss by using autobiographically-salient images to preserve the sense of self and stimulate emotions, such as nostalgia.

Nostalgia, a sentimental longing or wistful affection for the past (*The New Oxford Dictionary of English*, 1998, p. 1266) has attracted significant scholarly attention over the past decades. Nostalgia is a predominantly positive, social emotion (Sedikides & Wildschut, 2016), with a unique, bittersweet affective signature (Leunissen et al., 2021). Nostalgic reflections embody personally meaningful memories drawn from childhood and/or important relationships (Hepper et al., 2012; Hepper et al., 2014). In nostalgic reverie, a person feels content, warm, and comforted, yet longs to return to the past (Hepper et al., 2012). The emotion surfaces frequently (e.g., several times per week) (Hepper et al., 2021; Wildschut et al., 2006), throughout a person's lifetime (Hepper et al., 2021; Juhl et al., 2020; Madoglou et al., 2017), and resonates with cultures around the globe (Hepper et al., 2014; Sedikides et al., 2016). Importantly, empirical research has established that nostalgia is a psychological resource with a host of benefits. Nostalgia increases positive affect (Stephan et al., 2012; Wildschut et al., 2006), boosts self-esteem (Hepper et al., 2012; Wildschut et al., 2006), strengthens self-continuity (i.e., feeling connected between one's past and present self) (Sedikides et al., 2016), enhances a sense of social connectedness (Hepper et al., 2012; Sedikides & Wildschut, 2019; Zhou et al., 2008) and instils meaning in life (Sedikides & Wildschut, 2018).

In recent years, the psychological benefits of nostalgia have been investigated among people living with dementia. Ismail and colleagues (2018) experimentally induced nostalgia among people with early to moderate stage dementia. In two experiments, participants completed the ERT (Sedikides et al., 2015), in which they reflected on a nostalgic (vs. ordinary autobiographical) event and wrote a brief summary of the event (Routledge et al., 2008; Wildschut et al., 2006). In another experiment, participants listened to a song they had identified as being evocative of nostalgia (vs. a non-nostalgic song). Across all three experiments, participants in the nostalgia (compared to control) condition felt more socially connected, reported higher self-esteem, and had a greater sense of meaning in life. In all, nostalgia fortified the psychological resources of people with dementia.

On this basis, we hypothesized that, in the course of spatial navigation, landmarks that evoke nostalgia may convey psychological benefits to individuals living with dementia (Chiu et al., 2004). To test this, we created nostalgia-evoking pictures, which we embedded within a virtual environment. Virtual-environment technology can generate life-like and interactive design features (Ruddle et al., 1997), thus providing an ecologically valid context to implement our nostalgia induction. The virtual environment simulated an indoor hallway and participants were instructed to follow a designated route from a starting point to an end destination. To experimentally manipulate nostalgia, we systematically varied whether the pictures mounted along the route were nostalgic (nostalgia condition) or non-nostalgic (control condition). In Experiment 4.1 ($N = 173$), we pilot-tested our pictorial nostalgia induction on healthy adults. Having established its effectiveness, tolerability, and safety, we then tested the effect of our pictorial nostalgia induction among people with early to moderate stage AD in Experiment 4.2 ($N = 20$). Across both experiments, we hypothesized that nostalgia (compared to control) would boost key psychological resources: social connectedness, self-continuity, meaning in life, self-esteem, and positive affect (Cheung et al., 2013; Hepper et al., 2012; Routledge et al., 2011; Sedikides et al., 2013; Wildschut et al., 2006; Zhou et al., 2008). A secondary objective of Experiment 4.2 was to test the effect of nostalgia on picture recognition and spatial memory. According to Caduff and Timpf (2008), the overall salience of a spatial cue (e.g., a picture) is determined by (1) visual salience (e.g., size, contrast, and color), (2) structural salience (e.g., location), and (3) semantic salience, such as the cue's cultural, personal, or historical significance to a person. Nostalgic pictures should be high in semantic salience owing to their connection with unique and significant past memories. We therefore expected that nostalgic (compared to non-nostalgic) pictures would enhance picture recognition and spatial memory.

4.2 Experiment 4.1

Experiment 4.1 was a pilot study to examine the effectiveness, tolerability, and safety of our pictorial nostalgia induction in a sample of healthy adults, prior to implementing it among people living with AD in Experiment 4.2. We hypothesized that nostalgic (compared to non-nostalgic) pictures would increase social connectedness, self-continuity, meaning in life, self-esteem, and positive (but not negative) affect.

4.2.1 Methods

4.2.1.1 Participants and Design

One hundred and seventy-three adults (91 women, 82 men) took part in a 25-minute online experiment in return for monetary payment (£3.125). We recruited participants via Prolific and applied the following criteria: (1) aged 49-78 years, (2) UK nationality, and (3) normal or corrected to normal vision. One participant self-reported a mild cognitive impairment or dementia diagnosis. We randomly assigned participants to one of two conditions: nostalgia (n = 87) or control (n = 86). We conducted a power analysis for a between-subjects design, using G*Power 3.1 (Faul et al., 2007). It yielded a requisite sample size of 128 to detect a medium-sized effect (f = .25) with power equal to .80 and an alpha level of .05 (two-tailed). We exceeded this requirement.

4.2.1.2 Procedure and Materials

We generated the experiment using Qualtrics software. Prior to consent, we instructed participants to find a quiet, distraction-free space before they started the experiment. We first asked participants if they had a mild cognitive impairment or dementia diagnosis ("Have you ever been diagnosed with mild cognitive impairment or dementia?" *Yes* or *No*).

Individual-Difference Measures. Participants completed a series of individual-difference measures, assessing trait-level nostalgia, resilience, and spatial anxiety. We measured trait nostalgia with an adapted version of the Southampton Nostalgia Scale (Routledge et al., 2008). We first presented participants with two illustrations, each detailing a personal account of nostalgia. Then, participants rated seven items (e.g., "How much do you like to feel nostalgia?" "How often do you feel nostalgia when you think about things that happened when you were younger?") using a 7-point scale (1 = *not at all, very rarely*, 7 = *very much, very frequently*, α = .73, M = 4.79, SD = 0.94). We measured resilience using the 6-item Brief Resilience Scale (Smith et al., 2008). Participants rated each item on a 5-point scale (e.g., “I tend to bounce back quickly after hard times,” “I have a hard time making it through stressful events”; 1 = *strongly disagree*, 5 = *strongly agree*; α = .89, M = 3.33, SD = 0.84). We measured spatial anxiety using the 8-item Spatial Anxiety Scale (Lawton & Kallai, 2002). Items included a series of hypothetical spatial scenarios (e.g., “Finding my way to an appointment in an unfamiliar area of a city or town,” “Trying a new route that I think will be a shortcut, without a map”). Participants rated how anxious each scenario would make them feel, using a 5-point scale (1 = *not at all anxious*, 5 = *very anxious*, α = .94, M = 2.55, SD = 1.00).

Control Measures. We assessed participants’ familiarity with the term “nostalgia” (“How familiar are you with the meaning of the word nostalgia?”; 1= *not at all*, 4 = *very well*, M = 3.51, SD = 0.61. We also assessed participants’ previous experience with computer games (e.g., “How much experience do you have with playing computer games?”) and virtual reality environments (e.g., “How much experience do you have with playing computer games which involve a virtual environment technology [e.g., flight simulation]?”) using a 3-item Computer Experience Questionnaire (Rodgers et al., 2012). Participants used a 7-point scale to rate their experience level (1 = *no experience at all*, 7 = *a lot of previous and recent experience*; M = 4.15, SD = 1.09). Lastly, we recorded self-reported cognitive impairment using the 13-item Mild Cognitive Impairment Questionnaire (Dean et al., 2014). In this questionnaire, two subscales yield a score ranging from 0 to 100, with higher scores indicating greater impairment concerns. Seven items measured Practical Concerns (e.g., “Worry that you have forgotten what you had planned to do,” α = .88, M = 21.26, SD = 17.27) and six items measured Emotional Concerns (e.g., “Irritation or frustration about your memory problems,” α = .93, M = 17.56, SD = 21.60). Items were rated on a 5-point scale (0 = *never*, 4 = *always*).

Nostalgia Manipulation. We manipulated nostalgia by systematically varying the content of 14 pictures that were mounted on the walls along the route of a virtual environment. The pictures comprised various themes including TV series, films, musicians, cars, technology, sports figures (i.e., Olympians, footballers), and Royal Family events (see Appendix C.4). Nostalgia is a personally meaningful emotion that often revolves around childhood memories (Sedikides & Wildschut, 2018). We followed a nomothetic approach by tailoring the inductions to specific cohorts. Specifically, we selected the pictures according to the time period in which participants would have lived their childhood years (aged 6-11 years of age). For the nostalgia condition, we created three sets of nostalgic pictures according to the participants' current age and the decade (i.e., 1950s, 1960s, and 1970s) during which they lived most of their childhood. Participants in this condition viewed one of the three sets of nostalgic pictures, depending on their current age. For example, we conducted Experiment 4.1 in 2021, and so participants aged 49-58 would have lived at least three (out of five) of their childhood years in the 1970s. They would therefore view nostalgic pictures dated to this specific decade (e.g., picture of the Queen's Silver Jubilee in 1977). Participants aged 59-68 viewed nostalgic pictures from the 1960s (e.g., Princess Margaret and Antony Jones's wedding in 1960). Participants aged 69-78 viewed nostalgic pictures from the 1950s (e.g., the Queen's coronation in 1953). In the control condition, participants viewed thematically-matched control pictures dated between 2008-2020 (e.g., Prince William and Catherine Middleton's wedding in 2011; Figure 4.1). In total, we sourced 56 pictures from online search engines. We equalised the average luminance and global contrast of colored pictures using MATLAB to control the visual salience of the images.

Virtual Environment. We presented the pictures to participants within a virtual indoor environment using Unity software. We developed a standard virtual 3D environment that enabled participants to explore a route from a starting point to an end destination (Figure 4.2). The route included 10 turning points and nine decision-making points. Along the route, there were 14 wall-mounted pictures (nostalgic vs. control) that served as local landmarks. Participants first navigated the designated route three times with guidance from green arrows. After this, they navigated the route once without arrows. The virtual environment offered a first-person perspective (Figure 4.3). Participants controlled their movement using the "FORWARD," "BACKWARD," "LEFT," and "RIGHT" arrow keys.

Outcome Measures. After the experimental manipulation, participants completed a manipulation check and the dependent measures.[6] The manipulation check assessed the extent to which participants felt nostalgic in the present moment. We administered a validated three-item measure (Wildschut et al., 2010) ("Right now, I am feeling quite nostalgic," "Right now, I am having nostalgic feelings," and "I feel nostalgic at the moment"). Participants rated these items on a 6-point scale (1 = *strongly disagree*, 6 = *strongly agree*; α = .99, M = 2.71, SD = 1.60). Then, we assessed six psychological resources, using an adapted version of Hepper et al.'s (Hepper et al., 2012) Nostalgia Functions Scale, with the addition of a self-continuity measure (Sedikides et al., 2016). This generated a 12-item scale (two items per function) which assessed: social connectedness (e.g., "The pictures made me feel connected to loved ones," α = .91, M = 2.39, SD = 1.29), self-continuity (e.g., "The pictures made me feel closer to my past," α = .93, M = 3.08, SD = 1.60), meaning in life (e.g., "The pictures made me feel like life is meaningful," α = .96, M = 2.48, SD = 1.36), self-esteem (e.g., "The pictures made me feel good about myself," α = .91, M = 2.59, SD = 1.31), positive affect (e.g., "The pictures made me feel happy," α = .95, M = 3.56, SD = 1.46), and negative affect (e.g., "The pictures made me feel sad," α = .77, M = 1.58, SD = .84). Participants rated these items on a 6-point scale (1 = *strongly disagree*, 6 = *strongly agree*).

[6] We collected additional dependent and control variables for exploratory purposes (Appendix C.9).

Debrief. Lastly, we asked participants' a debriefing question (i.e., "*How did you find the game?*") to assess the tolerability and safety of the induction procedure. A debrief statement then finalised the study.

4.2.2 Results and Discussion

4.2.2.1 Control Measures

Familiarity with the meaning of the word "nostalgia" did not differ significantly between the nostalgia (M = 3.58, SD = 0.58) and control conditions (M = 3.45, SD = 0.62), $F(1, 171) = 2.10$, $p = .149$, $d = 0.22$. Computer experience (nostalgia condition: M = 4.15, SD = 1.17; control condition: M = 4.15, SD = 1.02) did not differ between conditions either, $F(1, 171) = 0.01$, $p = .939$, $d = 0.00$.

4.2.2.2 Demographic, Clinical, and Personality Characteristics

We present demographic, clinical, and personality characteristics in Table 4.1. The conditions did not significantly differ on any of these characteristics, with the exception of trait-level spatial anxiety. Participants in the control condition reported significantly higher spatial anxiety than those in the nostalgia condition. To control for this difference, we included spatial anxiety as a covariate in subsequent analyses.

4.2.2.3 Outcome Measures

We present descriptive and inferential statistics in Table 4.2. Participants in the nostalgia condition felt significantly more nostalgic than those in the control condition, confirming that the use of pictures to induce nostalgia was successful.

Crucially, participants in the nostalgia condition reported significantly higher levels of social connectedness, self-continuity, meaning in life, self-esteem, and positive affect than those in the control condition. The effect of nostalgia on negative affect was not statistically significant. Controlling for spatial anxiety did not alter the pattern of significant/non-significant findings, with one exception. When controlling for spatial anxiety, the previously marginal effect of nostalgia on meaning in life ($F[1, 171] = 3.24$, $p = 0.074$) became statistically significant (Table 4.2).

4.2.2.4 Supplementary Moderation Analyses

We next tested whether the effect of nostalgia on social connectedness, self-continuity, meaning in life, self-esteem, and positive affect was moderated by mild cognitive impairment (PROCESS macro, model 1; Hayes, 2022). We carried out separate moderation analysis for the two mild cognitive impairment subscales: practical concerns and emotional concerns. We entered each psychological function, in turn, into each model. Mild cognitive impairment did not moderate the effect of nostalgia on any of nostalgia's key psychological functions (see Appendix C.10).

4.2.2.5 Debrief

We examined participants' feedback of the virtual environment. We applied a simple coding scheme, which included the following categories: unrelated comments ($N = 6$), negative comments ($N = 18$), neutral comments ($N = 19$), positive comments ($N = 119$), and a mix of negative and positive comments ($N = 11$). In all, most of the participants' provided positive feedback (e.g., "interesting," "easy," "enjoyable" "fun"). Some participants', however, reported negative feedback. These comments referred to instances of getting lost, physical symptoms (e.g., "dizziness," "nausea"), and psychological symptoms (e.g., "frustrating," "difficult"). To mitigate this among people with AD, in Experiment 4.2, we implemented additional training with a set criteria to assess suitability and monitor any adverse effects that may occur.

Experiment 4.1 provides evidence that pictures are effective at experimentally inducing nostalgia. We selected pictures according to the decade (i.e., 1950s, 1960s, and 1970s) during which middle-aged older adults would have lived most of their childhood. In all, the manipulation provided a valid, effective, and safe induction of nostalgia in a virtual environment.

4.3 Experiment 4.2

In Experiment 4.2, we implemented the pictorial nostalgia induction among people living with early to moderate stage AD. To strengthen the induction further, we took an idiographic approach and selected images according to each participant's personal past experiences. We hypothesized that nostalgic (versus control) pictures would increase psychological resources by elevating social connectedness, self-continuity, meaning in life, self-esteem, and positive (but not negative) affect. As secondary hypotheses, we predicted that (1) participants would evince better recognition for nostalgic than control pictures, and (2) nostalgic (compared to control) pictures would enhance spatial memory.

4.3.1 Methods

The experiment received ethical approval from the University of Southampton ethics board[7] and a NHS Research Ethics Committee,[8] and gained site approval.[9] We also conducted Patient and Public Involvement work to help shape our nostalgia-induction procedure and virtual environment design (Appendix C.1).

4.3.1.1 Participants and Design

Twenty participants (8 women, 12 men, age range: 63-83, $M = 72.90$, $SD = 5.32$) completed the study (Figure 4.4). Each participant had a study partner (typically their spouse), who also completed a number questionnaires. All participants identified themselves as White. The sample comprised a variety of education levels, including GCSEs or equivalent ($n = 7$), University undergraduate programme ($n = 2$), University postgraduate programme ($n = 2$), doctoral degree ($n = 1$), and other ($n = 8$). Participants attended two 3-hour visits within an 8-week period. We adopted a within-subjects

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[7] Ethical approval received on 6th March 2020 (ERGO ref: 526320).
[8] South Central - Hampshire A Research Ethics Committee on the 13th July 2020 (REC ref: 20/SC/0210).
[9] From Southern Health NHS Foundation Trust, Research and Innovation Department.

(repeated measures) design (nostalgia vs. control). We predicated our power analysis on prior work (Ismail et al., 2018) and assumed a large-sized effect. Detecting an effect of this magnitude with power = .95 and α = .05 required 8 participants (i.e., G*Power 3.1) (Faul et al., 2007). We met this requirement.

All participants included in the study had:

- a diagnosis of probable AD in line with the National Institute on Aging and Alzheimer's Association (NIA-AA) (McKhann et al., 1984) or National Institute of Neurological and Communicative Disorders and Stroke Association – Alzheimer's Disease and Related Disorders Association criteria (NINCDS-ADRDA) (McKhann et al., 2011);
- early to moderate stage AD according a score of 18 or above on the Standardized Mini-Mental State Examination (SMMSE; Molloy et al., 1991) screening tool;
- normal or corrected-to-normal vision;
- a willing study partner or carer to attend and take part. The study partner had >10 hours weekly contact with the participant.

Each participant:

- gave informed consent before participating in the study;
- had to comply with cognitive testing procedures;
- was fluent in English.

Participants were excluded if they had:

- a confirmed diagnosis of other dementia type;
- a significant history or current premorbid psychiatric problems including severe anxiety or depression, including substance misuse;

- any condition or disorder which could affect the patient's safety during participation;
- a significant neurological disease other than AD which may affect cognition;
- any previous or current medical condition that may impact cognitive performance;
- a history or recent experiences (e.g., within the last 6 months) of motion sickness or vertigo.

Additionally, each participant would be excluded if they were:

- unable to provide consent because they lacked capacity or demonstrated a loss of capacity over the course of the two study visits;
- unwilling to attend two separate sessions.

4.3.1.2 Procedure and Materials

Recruitment. We recruited participants at the Memory Assessment and Research Centre (MARC), Moorgreen Hospital, Southampton, UK. We identified suitable participants using a database of volunteers who had consented to be contacted about research opportunities held at MARC. We logged the number of participants assessed for suitability, the number approached to participate in the study, and the number and reason for those who declined to take part (see Figure 4.3).

Sample Identification. All judgments about whether participants met the inclusion and exclusion criteria was made by the researcher (AO) or by a member of the research team (SS) embedded within MARC. We made decisions regarding the study criteria based on clinical notes including electronic medical records and recent cognitive assessments as well as discussions with potential participants. The researcher (AO) contacted participants (and their study partners) by phone and email. After a brief verbal introduction to the study, if interested, participants received the participant information sheets by email or post. A week later, potential participants were contacted by phone to discuss the study further and arrange a date for them to take part. If they were not interested, no further contact was made. We explained verbally and in writing that participation in the study is independent of the clinical service that they receive, and that declining the opportunity to participate will not affect their clinical care.

First Visit.

Informed Consent. We obtained informed consent from all the participants (and their study partners) prior to the start of any study-related procedures and in accordance with the Declaration of Helsinki (1964) and ICH Good Clinical Practice guidelines. We provided participants with written information about the design, purpose, and duration of the study and gave them sufficient time (i.e., a minimum of 24 hours) to make an informed decision regarding whether to take part. The researcher (AO) verbally explained the study and made participants aware of the potential risks that may occur. We answered all the questions the participant or their study partners had prior to the consent forms being signed.

Screening. After consent, we administered the SMMSE (Molloy et al, 1991) —a well-established measure of cognitive function in elderly people. We used this tool to assess cognitive disability at entry to ensure participants met the inclusion criteria (i.e., mild to moderate probable AD SMMSE score of 18 or above).

Joystick-Computer Training. 28 participants entered the experiment (see Figure 4.4) after screening, which took place within a clinical meeting room at Memory Assessment and Research Centre. The room contained a single computer monitor, which connected to a Dell laptop with a standard Windows 7 operating system and a Thrustmaster USB joystick. Participants had to complete joystick training to continue in the study. The purpose of this was to (1) introduce participants to virtual environment technology, and (2) to offer guidance in how to maneuver within a virtual space using a joystick. In the training session, participants completed three training tasks. All three virtual environments offered a first-person perspective. Participants could explore each environment by moving the joystick in "forwards," "backwards," "left," and "right" motion, but could not look up or down, or interact with items.

Before commencing the tasks, we informed participants' that it is possible they may experience temporary motion sickness or nausea, and if this event was to occur, to stop the task immediately and inform the experimenter. In the first training task, participants explored an outdoor virtual environment which depicted a naturalistic model of the Psychology building and surrounding areas of the University of Southampton campus (e.g., car park, green spaces) (Allison & Redhead, 2017; Allison et al., 2017). The experimenter gave verbal guidance on where participants could explore. In the second training task, participants completed the free-movement pattern Y-maze (Cleal et al., 2021). Participants learned how to turn at Y-shaped junctions within a virtual maze. Each task lasted three minutes. The third training task involved a route-learning task. We acquainted participants with the task format before they completed a more challenging version later in the study. The virtual environment presented an indoor hallway (Figure 4.5). The task required participants to follow a specific route, including three turning points and one T-shaped junction (Figure 4.6). The path contained three neutral wall-mounted pictures, which we sourced from the Open Affective Standardized Image Set (Kurdi et al., 2017). Participants navigated a guided route from a starting point to an end destination. Initially, participants completed three training trials in which green arrows directed them along a designated route. In a final trial, participants had to navigate the same route without the arrows.

Participants entered the study if they met the following criteria: (1) felt comfortable using the technology, (2) successfully moved around the virtual environments using the joystick, and (3) completed all three training tasks. If participants did not meet the criteria, the experimenter thanked them for their participation and ended the study. If participants met the criteria, the experimenter concluded the session with a brief demonstration of the picture-recognition and spatial-memory tasks. The experimenter presented participants with one (out of the three) neutral pictures encountered along the virtual route in the third training task. The experimenter asked a series of questions that captured picture recognition ("Did you see this picture during the game?" "*Yes*" or "*no*"), spatial memory ("In the game, which way did you have to go at this picture?" "*Left*," "*right*," "*straight on*," or "*not sure*"), and confidence ("How confident do you feel about your answer to the previous question(s)?" 1 = *not confident at all*, 5 = *very confident*).

Individual-Difference Measures. Next, participants (and their study partners) completed a series of individual-difference questionnaires. The experimenter verbally read out the questions and recorded the participants' responses. The study partner independently completed the same set of individual-difference questionnaires, providing an informant report. The person selected as the study partner knew the participant well (spent ≥ 10 hours per week) and could therefore draw from their personal experience. We collected both self-reports and informant-reports to obtain a richer account of the participants' personality. We used the same set of questionnaires described in Experiment 4.1, assessing trait-level nostalgia (self-report: $M = 5.09$, $SD = 1.28$; informant-report: $M = 4.47$, $SD = 1.70$), spatial anxiety (self-report: $M = 3.06$, $SD = 0.94$; informant-report: $M = 3.62$, $SD = 0.82$), and resilience (self-report: $M = 3.54$, $SD = 0.74$; informant-report: $M = 3.29$, $SD = 0.92$). Study-partner questionnaires referred to the participant in question (e.g., "How often does your partner feel nostalgia when he or she thinks about things that happened when they were younger?"). We also measured participants' experience with computer games and virtual-reality technology, as in Experiment 4.1 ($M = 2.93$, $SD = 1.16$).

Semi-Structured Interview. To conclude the first study visit, participants (and their study partners) took part in a semi-structured interview on the topic, "Events from your past." The aim of the interview was to use participants' past memories to guide the selection of personalised nostalgic (vs. control) pictures. The interviews ranged from 26 minutes to 1 hour and 38 minutes (M = 54.09 minutes). We first asked participants' the generation or era they felt part of and grew up in their youth. These questions initially provided insight into a meaningful time-period in their lives. The remaining interview questions focused on various themes including transport (e.g., first car, bicycle, or motorbike), sports (e.g., hobbies, live events, historical moments, and favourite sports figures), technology (e.g., old-fashioned cameras, computers, or vinyl record players), TV and film (e.g., first television set, favourite movies, shows, cinema venues, or TV adverts), music (e.g., favourite musicians, live concerts, dances, or a wedding song), places (e.g., where they grew up, day trips or holidays, hang-out-spots with friends or family), fashion (e.g., clothing style, fashion trends, or work uniform), and loved ones and important events (e.g., special occasions, momentous life events) (see Appendix C.6). The interview comprised 43 questions (see Appendix C.6). For each theme, the questioning style started broad (e.g., "When you were a child or young adult, how did you travel around?"), and then became more focused and specific (e.g., "What was the brand, make, and colour of your first car/bicycle/motorcycle?" "After reflecting on this, does it bring back any fond memories?"). The interviewer adapted the questions to the participants' interests. For instance, if a participant did not take much interest in a particular theme (e.g., sport), the interviewer would move onto the next theme (e.g., music), which then may elicit a fond memory (e.g., dancing at a ballroom where they met their partner). The interviewer would also ask for additional details when needed. For example, if a participant recalled a childhood memory involving a family road trip to the beach in 1960s, the interviewer may ask follow-up about the specific place (e.g., St Ives, Cornwall) and the vehicle (e.g., 1966 blue Ford Popular) to help inform picture selection. At the end, the interviewer asked participants' to identify which of themes triggered the most vivid and fond memories from their past. Responses to this final question guided the location of the nostalgic pictures within the virtual environment (discussed further below).

Pictorial Nostalgia Induction. In preparation of the second study visit, we created our nostalgia-induction materials. A member of the research team listened to the semi-structured interview recordings to identify, for each participant, personally nostalgic content that could guide picture selection. We used the interviews to select 10 personalized nostalgic pictures that mirrored each participant's unique past experiences. In total, we generated 210 personalized nostalgic pictures and sourced them from online search engines (e.g., Google, Unsplash). We selected 10 control pictures to match the themes of the nostalgic pictures. For example, if one of the nostalgic pictures depicted a vintage car, we would select a control picture depicting a modern car. As in Experiment 4.1, we controlled the visual salience of the colored (but not black and white) pictures. After selecting the pictures, another member of the research team inserted the personalized nostalgic and control images (nine for each condition) into two separate virtual environments. The experimenter informed the other team member (inserting the images into the virtual environment), which pictures were the most nostalgic for each individual. Along the virtual route some landmarks were more visible (i.e., located on the guided route in full view at a decision point) than others (i.e., located off the guided route in partial view down a dead-end path). We positioned the most nostalgic pictures at the most visible landmark locations to further enhance the induction procedure.

Randomisation and Blinding. We used a within-subjects design and, accordingly, participants completed the navigation task twice; once in a virtual environment with wall-mounted control pictures and once in a virtual environment with nostalgic pictures. We counterbalanced the order of these two tasks and randomly assigned participants to complete either the control or nostalgia condition first. We randomised the condition order using a random number generator and then, numerically labelled the two environments (i.e., task 1, task 2) so that the experimenter was unaware of condition order. Eleven participants completed the nostalgia condition first and nine participants completed the control condition first.

Second Visit.

Consent. At the start of the second study visit, we re-assessed capacity to consent. The researcher (AO) administered the Evaluation to Sign Consent Measure (e.g., "What are two potential risks?" "What is expected from you in this study?") to reassess whether the participant presented capacity to take part in the study (Resnick et al. 2007). If the participant did not show sufficient understanding of the study, the researcher (AO) asked the participant if they wish to continuity in the study. If they agreed, the researcher (AO) would fully explain the study and re-consent the participant.

Joystick Training Repeated. Participants then repeated the joystick-computer training completed at the first visit.

Virtual Environments. We presented the pictures to participants within a virtual indoor environment. We created two distinct experimental conditions by altering (1) the interior design and (2) the designated route. In terms of design, one environment depicted a blue carpet and yellow walls, whereas the other presented a wooden floor and grey walls (Figure 4.7). In terms of the route layout, each environment contained a T-junction, L-shaped junction, and a 4-way intersection (Figures 4.8-9). Across the two route layouts, we varied the order at which each junction type was encountered from the starting point to the end box. In all, each route included six/seven turning points and four decision-making points, with nine wall-mounted pictures (nostalgic vs. control). In one environment, we added a seventh turning point after the final T-shaped junction in order to hide the end box from the participants' view (Figure 4.9). The length of the route across both environments equaled 136 meters.

Participants completed two route-learning tasks in a counterbalanced order; one with nostalgic pictures tailored to their past memories and one with control pictures. We crossed the two experimental conditions (nostalgia versus control), with two distinct environments, which included a variation in both the route layout (six versus seven turns) and interior design (yellow versus grey walls), such that participants were equally likely to complete the nostalgia condition and control condition in the six-turn environment as in the seven-turn environment, as well as in the yellow-walled environment as in the grey-walled environment.

Participants practiced each route a minimum of four and a maximum of eight times guided by green arrows and, then, once without arrows. We applied a 3-minute timer to the unguided route to limit the time spent in the environment, in the event that a participant became lost. Participants had to navigate at least three training trials independently (i.e., without verbal guidance) and correctly (i.e., with no errors). We allowed participants to navigate the guided route up to eight times before completing the unguided route. If a participant diverged from the guided route during the training trials, the experimenter would offer prompts (e.g., "follow the green arrows along the path"). During the unguided trial, if a participant became lost, the experimenter would offer suggestions (e.g., "retrace your steps to the beginning and try again").

Outcome Measures. In each experimental condition, participants completed a manipulation check and measures of psychological resources, as in Experiment 4.1. In addition, participants twice completed picture-recognition and spatial-memory tasks, once with nostalgic pictures and once with control pictures. We presented participants with five pictures per task, four of which they had encountered in the virtual environment and one they had not seen before. Participants recorded ("*Yes,*" "*No*") whether they saw the picture in the virtual environment. We scored picture recognition by recording the number of correct responses (maximum score = 5). If participants recognized the picture (i.e., selected

"*Yes*"), we asked them to recall the direction they had to turn at the picture ("*Left,*" "*Right,*" "*Straight on,*" "*Not sure*"). We recorded the proportion of correct decisions as a measure of spatial memory (maximum score = 4). Participants skipped this question if they reported that they did not see the picture (i.e., selected *"No"*). Participants also rated how confident they felt in their answer (1 = *not confident at all*, 5 = *very confident*).

Control Measures. We gave participants a 45-minute to 1-hour break between the two experimental conditions to minimise carryover effects. During this interval, the experimenter administered two questionnaires to the study partner. One questionnaire assessed the participant's wayfinding effectiveness and the other assessed activities of daily living. We assessed everyday wayfinding ability using a modified version of the Wayfinding Effectiveness Scale (Algase et al., 2007). This questionnaire included 17 items measuring topographical disorientation symptoms (e.g., "He/she can find his/her way around area of residence, if the route and destination were familiar," "He/she has been lost and required help to find way"). Study partners used a 5-point scale to rate frequency or severity (1 = *never*, 5 = *always*, $M = 2.41$, $SD = 0.49$, $\alpha = .82$).

We assessed daily living ability using the Alzheimer's Disease Cooperative Study – Activities of Daily Living Inventory (Galasko et al., 1997). The inventory included 23 items (e.g., "During the past 4 weeks, which best describes how participants' name usually managed to find his/her personal belongings at home"). The experimenter scored the study partners' responses depending on the degree of supervision or help the individual required (3 = *without supervision or help*, 2 = *with supervision*, 1 = *with physical help*, 0 = *{participants' name} did not find personal belongings*). The questionnaire yields a score ranging from 0 to 78 ($M = 64.15$, $SD = 8.41$, $\alpha = .80$), with lower scores indicating greater impairment.

After participants completed the second experimental condition and subsequent outcome measures, we assessed familiarity with nostalgia (*M* = 3.35, *SD* = 0.59), as in Experiment 4.1. Then, we asked participants two debriefing questions (i.e., "How did you find the two computer games, 'Pathfinder'?" and "Did you find one game easier than the other or perhaps the same?").

Debrief and study close. The experimenter debriefed the participants and their study partners. We informed them of the underlying aim (i.e., to induce nostalgia) and explained how the interview at the first visit guided the imagery they encountered within the virtual environment at the second visit. We provided participants with a list of the pictures used in the study (see Appendix C.8), including an acknowledgement of the copyright owners. Lastly, we sent a letter to the participants' GP to inform them of their participation in the study.

After study closure, participants received a lay summary of study results. Prior to distribution, the researcher (AO) presented a draft version of the lay summary report to a voluntary reference group at MARC to ensure the language used was layperson-friendly and jargon-free.

4.3.2 Results and Discussion

4.3.2.1 Outcome Measures

We present descriptive and inferential statistics in Table 4.3. Participants felt significantly more nostalgic in the nostalgia (than control) condition. The personalized nostalgia manipulation was effective. Crucially, participants reported significantly higher levels of social connectedness, self-continuity, meaning in life, self-esteem, and positive affect in the nostalgia (than control) condition. The effect of nostalgia on negative affect was not statistically significant.

Participants viewed five pictures after they completed each condition (nostalgia versus control) and recorded whether they saw the picture in the virtual environment.

Participants were significantly more accurate at recognizing nostalgic (than control) pictures. Participants also recorded the direction they had to turn at each picture. The number of correct decisions was higher for the nostalgic than control pictures, but this difference was not statistically significant. For spatial memory, the mean scores were relatively low (control condition: $M = 1.10$, nostalgia condition: $M = 1.55$). We explored this further and identified moderate skewness after the nostalgia condition (0.47) and high skewness after the control condition (1.06), indicating a potential floor effect in the latter condition. Lastly, there was no significant difference between conditions in rated confidence with regard to these decisions either.

4.3.2.2 Supplementary Analyses: Individual Differences

We present descriptive statistics in Table 4.4. Self-reports and informant-reports for each individual difference variable were positively and significantly correlated (trait nostalgia: $r = .51$, $p = 0.020$; resilience: $r = .57$, $p = 0.008$; spatial anxiety: $r = .54$, $p = 0.014$). Self-reported spatial anxiety was significantly lower than informant-reported spatial anxiety, but this was not the case for trait nostalgia or resilience.

We entered each individual difference (self- and informant- reports respectively) and control variable as a covariate (mean-centered) into a series of repeated measures ANCOVAs. The pattern of significant and non-significant results did not change.

In Experiment 4.2, we used an idiographic approach to tailor the pictorial nostalgia induction to each participant's personal memories. Encountering these personalized nostalgic (compared to control) pictures in a virtual environment significantly increased state nostalgia and boosted psychological resources for people living with AD. Participants also evinced better recognition of nostalgic (than control) pictures.

4.4 General Discussion

4.4.1. Summary of Findings

Our research shows that pictures tailored to induce nostalgia convey psychological benefits when encountered in a virtual environment. In Experiment 4.1, we generated nostalgic images that reflected the decade during which healthy adults lived most of their childhood—a nomothetic approach focused on a specific cohort of individuals. In Experiment 4.2, we personalised the images further by selecting pictures that reflected specific memories of people with AD—an idiographic approach focused on each individual's unique personal past. In both experiments, nostalgic pictures (compared to thematically-matched control pictures) that were embedded within a virtual environment elicited nostalgia and boosted psychological resources. These findings are in line with previous work among non-clinical (Routledge, 2015; Sedikides & Wildschut, 2018; Sedikides et al., 2015) and clinical populations (Dodd et al., 2022; Ismail et al., 2018; Ismail et al., 2022).

People living with AD display impairments in recognizing landmarks (Monacelli et al., 2003). In a real world study, memorabilia and personal pictures helped people with dementia recognize their own rooms (Namazi et al., 1991; Nolan et al., 2002). Corroborating this finding, our work demonstrated that landmarks in the form of nostalgic pictures significantly improved recognition ability. For spatial memory, however, we did not find a statistically significant difference between the nostalgia and control condition. Spatial memory comprised recalling a directional decision (i.e., left, right, and straight on) at a specific picture, which in contrast to picture recognition, required greater spatial skill. Navigation difficulties emerge early on in AD (Cushman et al., 2008; Kavcic & Duffy, 2003), here, we observed relatively low means scores for spatial memory, with particularly high skewness in the control condition. Taken together, one possibility may be that challenging spatial-memory produced a floor effect.

4.4.2 Strengths and Limitations

Ratings on the nostalgia state and resources scale were higher when pictures were tailored to an individual's past (Experiment 4.2), compared to pictures generally associated with a childhood decade (Experiment 4.1), indicating that, when inducing nostalgia, adopting an idiographic approach may strengthen the potency of the emotion. Laypeople generally treasure personal pictures and memorabilia associated with loves ones and special occasions (Hepper et al., 2012). Here, we gathered unique picture content from various time-periods, which otherwise could be difficult or expensive to obtain in the physical world (e.g., old-fashioned cars). Sourcing images from the internet made significant places, some of which no longer exist, accessible (e.g., churches, local pubs, and music venues). Although personalising images to individual memories effectively triggered nostalgia, the procedure itself, was time intensive. We recognise that this may not be feasible for larger experimental studies. Rather, we hope that our personalised approach in harnessing nostalgia inspires clinical interventions.

We add to the growing literature that nostalgia conveys psychological and physical health benefits to vulnerable populations (e.g., immigrants, civil war refugees, people experiencing bereavement, and people with dementia, for review see; Wildschut & Sedikides, 2023). Here, we initially recruited people with an AD diagnosis. We expect that nostalgia holds broad clinical potential, independent of a medical condition or disorder. Thus, an important next step for future studies is to investigate whether nostalgic pictures would provide similar benefits for people with other types of dementia (e.g., vascular dementia, Lewy body dementia, or a mixed form of dementia types, or posterior cortical atrophy) (McKeith, 2002; Román et al., 1993; Yong et al., 2018) and/or topographical disorientation disorders (Aguirre & D'Esposito, 1999; Iaria & Barton, 2010).

4.4.3 Broader Implications

Distinctive landmarks are critical for supporting navigation (Caduff & Timpf, 2008). As AD progresses, it is possible that the need for landmarks with more meaningful characteristics will increase. Therefore, identifying significant emotive content to generate a salient landmark is key for creating a dementia-friendly space (Davis & Weisbeck, 2016). Infusing environments with nostalgia could help address design suggestions by providing a therapeutic visual aid. Adding nostalgic items into existing facilities is a relatively cost-effective strategy and could be easily implemented. Environmental guidelines (Department of Health, 2015) should consider outlining more detailed, scientific evidence with regards to (nostalgic) landmarks that effectively boost psychological resources.

Aside from design, nostalgic sensory tools offer broad clinical benefits. Older people with memory difficulties highlight that meaningful cues also stimulate social interaction (O'Malley et al., 2018). For example, in a care home, installing digital photo albums transformed care interactions from task-orientated to interpersonal (Williams et al., 2011). Pictures could also be utilized in therapy-related practices. Reminiscence activities routinely use visual prompts to help people remember the past (Huber et al., 2019; Kaminsky, 2014). Although reminiscence is a popular psychosocial intervention, scientific evidence regarding its efficacy is inconsistent (Woods et al., 2018). Given that nostalgia enhances the psychological wellbeing of people with dementia (Dodd et al., 2022; Ismail et al., 2018; Ismail et al., 2022), interventions specifically triggering nostalgia (as opposed to general reminiscences) may advance therapy development.

4.4.4 Coda

In two experiments, we developed a pictorial nostalgia induction within a life-like virtual environment. Our findings demonstrated that nostalgic pictures boost psychological resources and enhance the recognition of landmarks for people with AD. Our work has valuable real-world applications, most notably to dementia design.

Table 4.1

Demographic, Clinical, and Personality Characteristics in Experiment 4.1

	Control *n* or *M* (*SD*)	Nostalgia *n* or *M* (*SD*)	Difference	*p*
Age	57.64 (6.68)	56.93 (5.53)	$F(1, 171) = 0.59$	0.442
Sex				
Women	42	40	$\chi^2(1) = 0.14$	0.706
Men	44	47		
Ethnicity				
Asian/Asian British	3	2	$\chi^2(4) = 3.55$	0.470
Black/African/Caribbean/ Black British	0	2		
Mixed ethnic groups	2	1		
White	80	82		
Did not wish to state	1	0		
Highest education level				
Primary School	1	0	$\chi^2(6) = 5.05$	0.538
GCSEs or equivalent	16	14		
A levels or equivalent	26	18		
Undergraduate degree	29	36		
Postgraduate degree	11	12		
Doctoral degree	2	4		
Other	1	3		
MCI or dementia diagnosis	1	0	$\chi^2(1) = 1.02$	0.313
Cognitive impairment				
Practical Concerns	22.18 (19.14)	20.36 (15.25)	$F(171) = 0.48$	0.491
Emotional Concerns	18.22 (23.47)	16.91 (19.70)	$F(171) = 0.16$	0.691
Personality Traits				
Nostalgia Proneness	4.86 (.93)	4.71 (.95)	$F(171) = 1.09$	0.297
Resilience	3.24 (.81)	3.42 (.85)	$F(171) = 2.04$	0.155
Spatial Anxiety	2.71 (1.04)	2.39 (.95)	$F(171) = 4.41$	0.037

Note. MCI = Mild Cognitive Impairment.

Table 4.2

Descriptive and Inferential Statistics in Experiment 4.1

	Control *M* (*SD*)	Nostalgia *M* (*SD*)	$F(1, 170)$	p	η_p^2
Manipulation check	2.30 (1.42)	3.11 (1.67)	12.34	0.001	0.068
Social connectedness	2.06 (1.18)	2.71 (1.33)	12.25	0.001	0.067
Self-continuity	2.42 (1.46)	3.74 (1.46)	12.41	< 0.001	0.181
Meaning in life	2.29 (1.33)	2.66 (1.38)	4.16	0.043	0.024
Self-esteem	2.28 (1.24)	2.90 (1.31)	10.68	0.001	0.059
Positive affect	3.19 (1.43)	3.93 (1.40)	12.37	0.001	0.068
Negative affect	1.53 (0.77)	1.63 (0.90)	1.49	0.225	0.009

Note. Inferential statistics are from an Analysis of Covariance (ANCOVA) which controlled for trait-level spatial anxiety. η_p^2 denotes proportion of variance accounted for by the nostalgia manipulation.

Table 4.3

Means and Standard Deviations for Outcome Variables in Experiment 4.2

	Control *M* (*SD*)	Nostalgia *M* (*SD*)	$F(1, 19)$	p	η_p^2
Manipulation check	2.30 (1.42)	4.75 (1.44)	21.06	< 0.001	0.526
Social connectedness	2.50 (1.72)	4.03 (1.70)	21.11*	< 0.001	0.540
Self-continuity	2.85 (1.61)	5.30 (1.25)	44.77	< 0.001	0.702
Meaning in life	3.18 (1.79)	4.18 (1.61)	8.74	0.008	0.315
Self-esteem	3.18 (1.42)	4.48 (1.63)	19.34	< 0.001	0.504
Positive affect	3.87 (1.37)	5.20 (0.97)	16.62	0.001	0.467
Negative affect	1.68 (0.21)	1.65 (0.83)	0.01	0.928	0.000
Picture recognition	3.40 (1.47)	4.15 (1.04)	9.65*	0.007	0.321
Spatial memory	1.10 (1.41)	1.55 (1.28)	2.66*	0.119	0.123
Confidence	3.71 (0.80)	3.63 (0.74)	0.24*	0.629	0.010

Note. η_p^2 denotes proportion of variance accounted for by nostalgia manipulation. *$F(1, 18)$, missing value due to a technical error or a participant misunderstanding a question.

Table 4.4

Means and Standard Deviations for Individual Difference Variables in Experiment 4.2

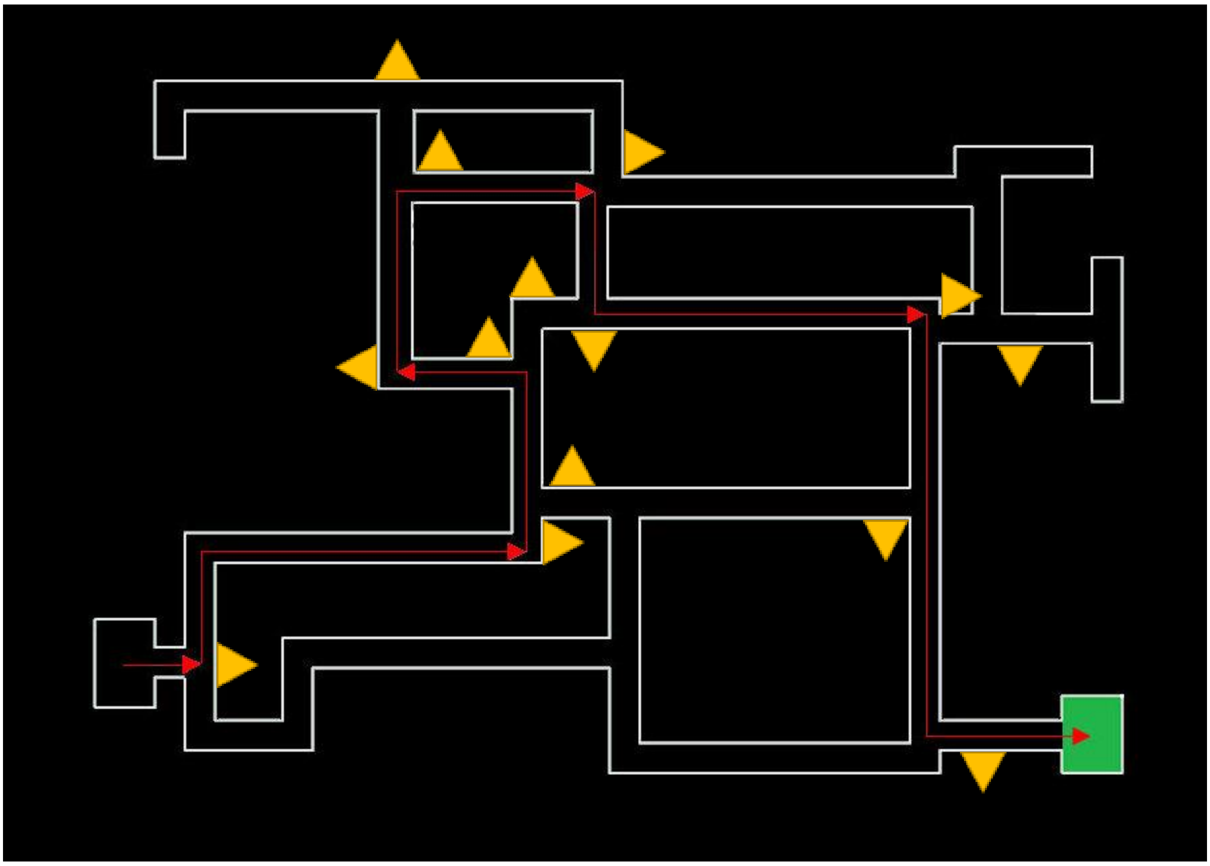
	Participant		Partner			
	M (*SD*)	α	*M* (*SD*)	α	Difference	*p*
Trait nostalgia	5.09 (1.28)	0.92	4.47 (1.70)	0.96	$F(19) = 3.31$	0.085
Resilience	3.54 (0.74)	0.85	3.29 (0.92)	0.95	$F(19) = 2.04$	0.168
Spatial anxiety	3.06 (0.94)	0.89	3.62 (0.82)	0.95	$F(19) = -8.76$	0.008

Figure 4.1

Examples of Nostalgic and Control Pictures in Experiment 4.1

Figure 4.2

Route Map for the Virtual Environment in Experiment 4.1



Note. Birds eye view perspective of the route map and layout. The red arrows illustrate the specified route and the green box highlights the end destination. The yellow triangles highlight the position of the 14 nostalgic or control pictures.

Figure 4.3

Virtual Environment Presentation in Experiment 4.1

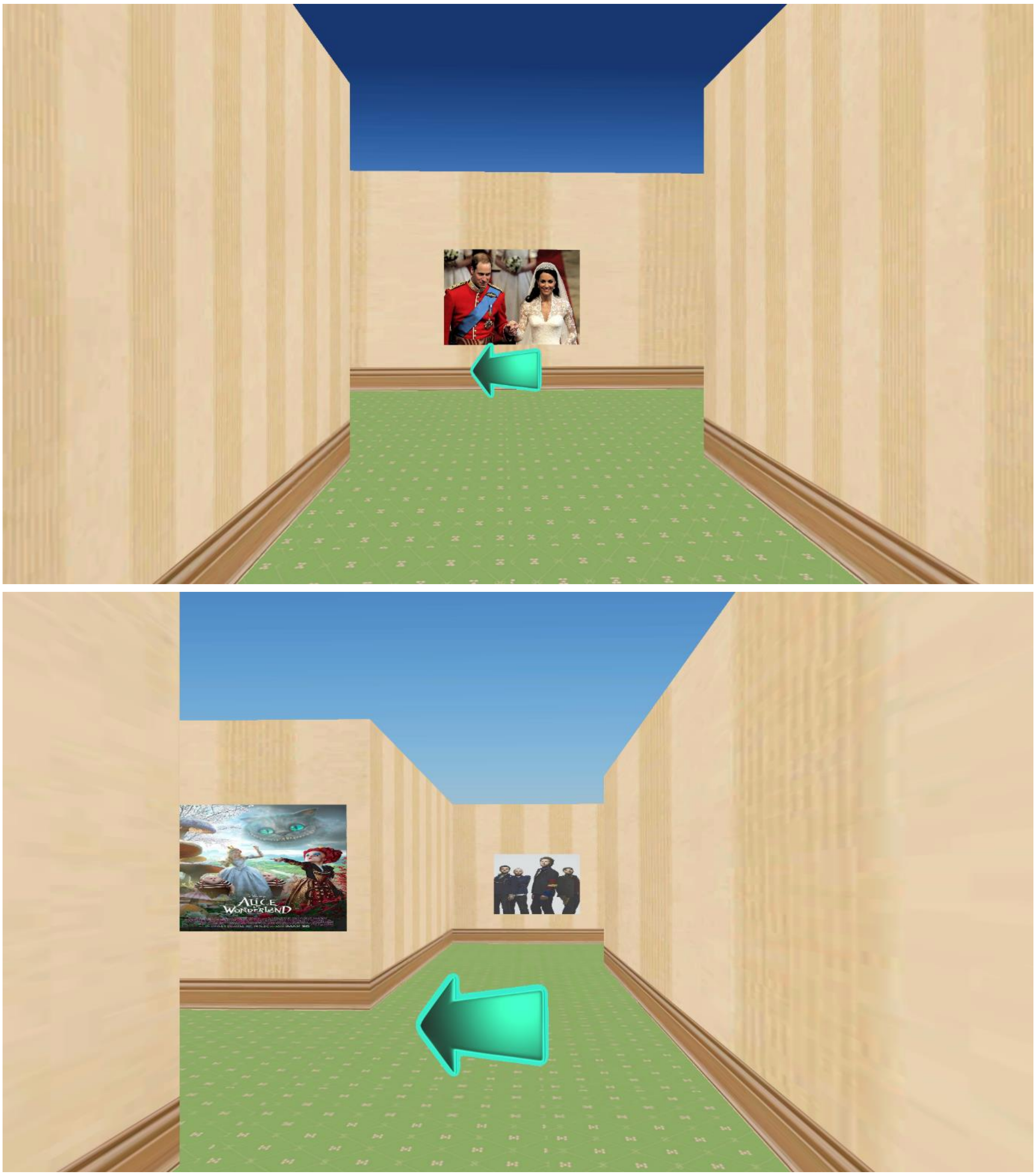


Figure 4.4

CONSORT Flow Chart Illustrating Recruitment to Experiment 4.2.

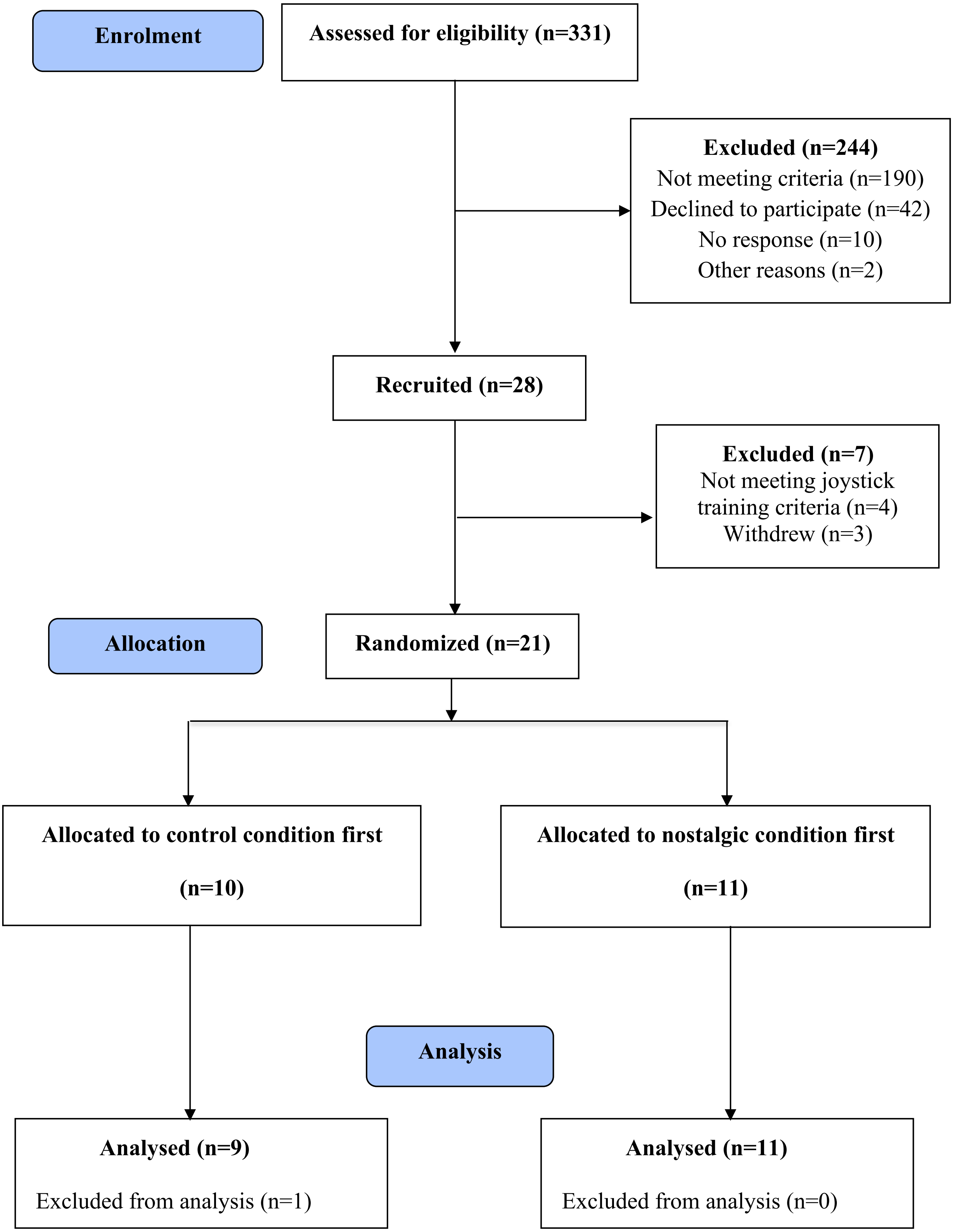
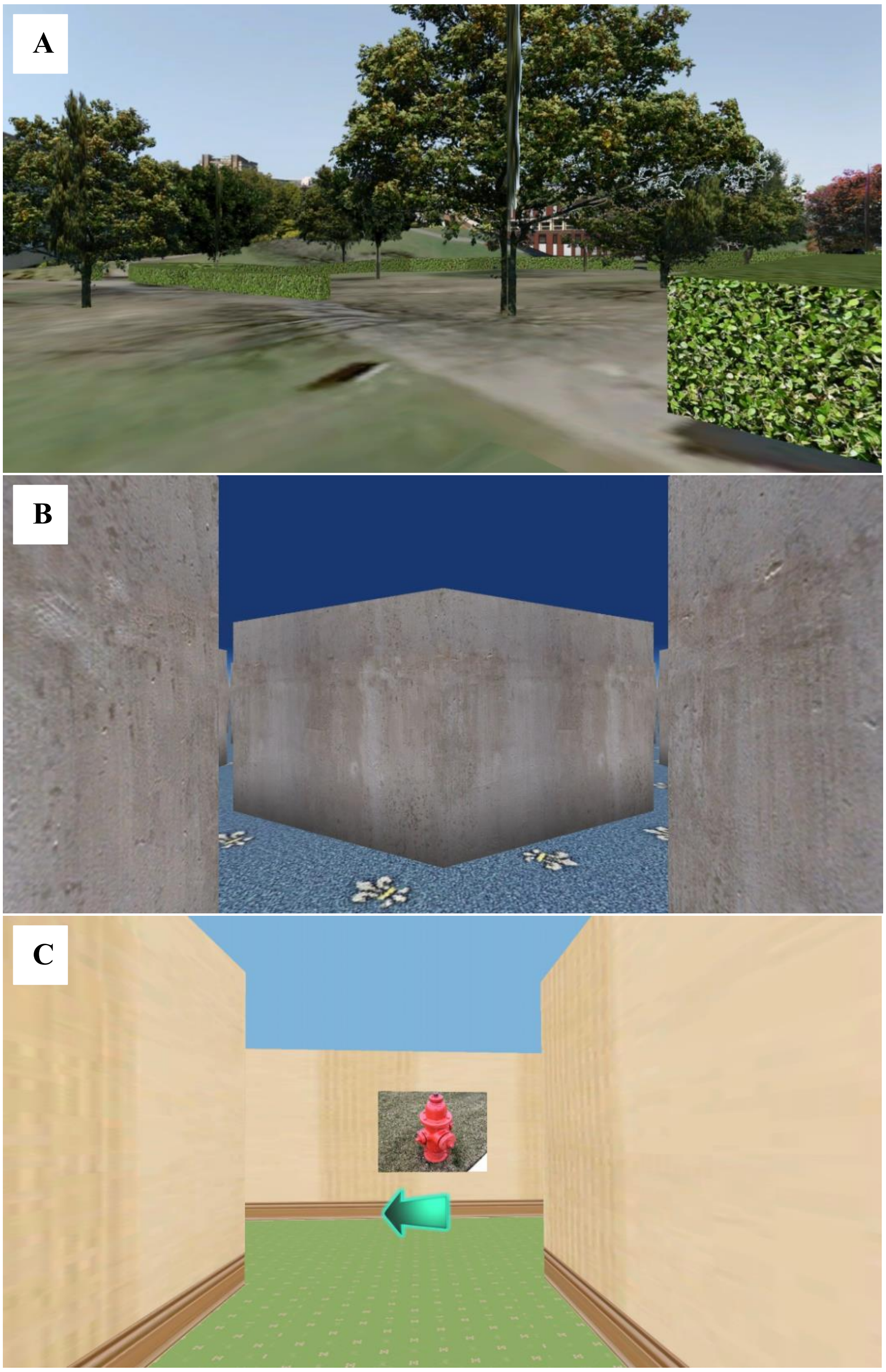


Figure 4.5

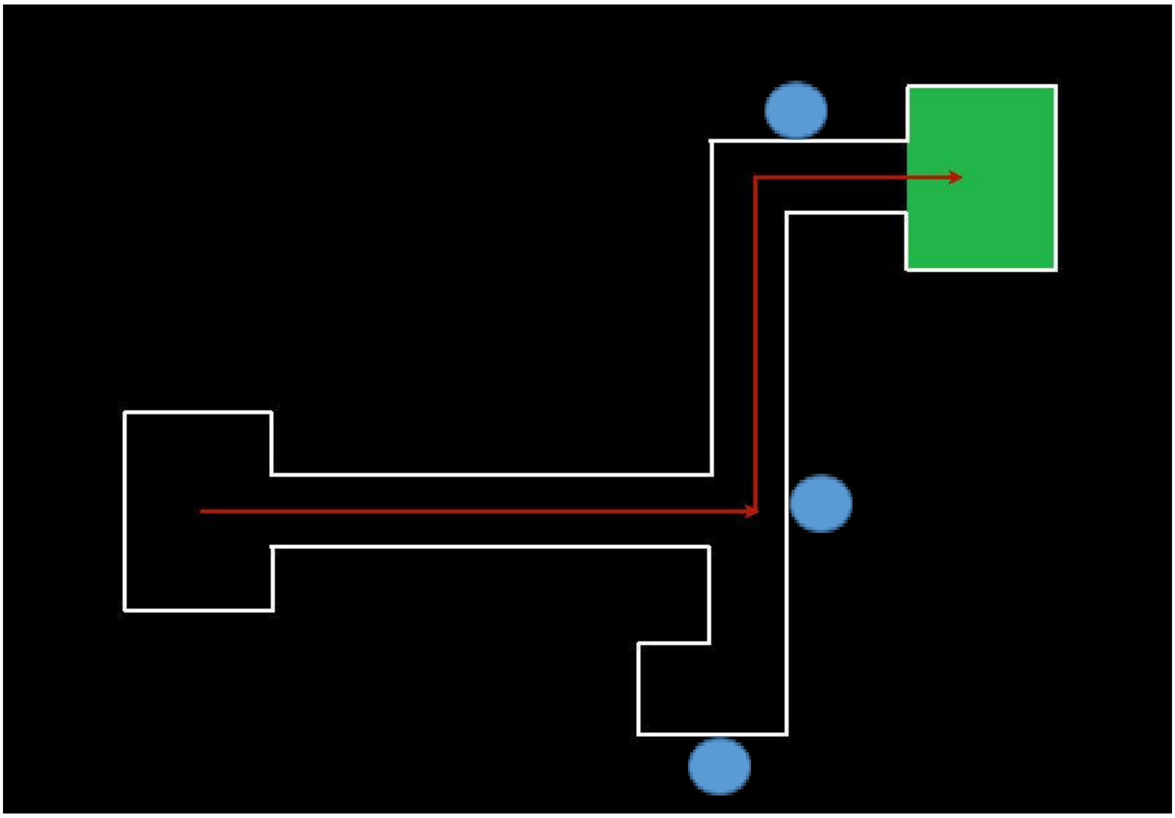
Virtual Environment Presentation of the Joystick Training Tasks in Experiment 4.2.



Note. A = Naturalistic model of University of Southampton campus. B = Free movement pattern Y-maze. C = Training route-learning task.

Figure 4.6

Route Map for the Training Route-Learning Task in Experiment 4.2



Note. Bird's eye view perspective of the route map and layout. The red arrows illustrate the specified route and the green box highlights the end destination. The blue circles highlight the position of the neutral pictures.

Figure 4.7

Virtual Environment Presentation of the Experimental Route-Learning Tasks in Experiment 4.2

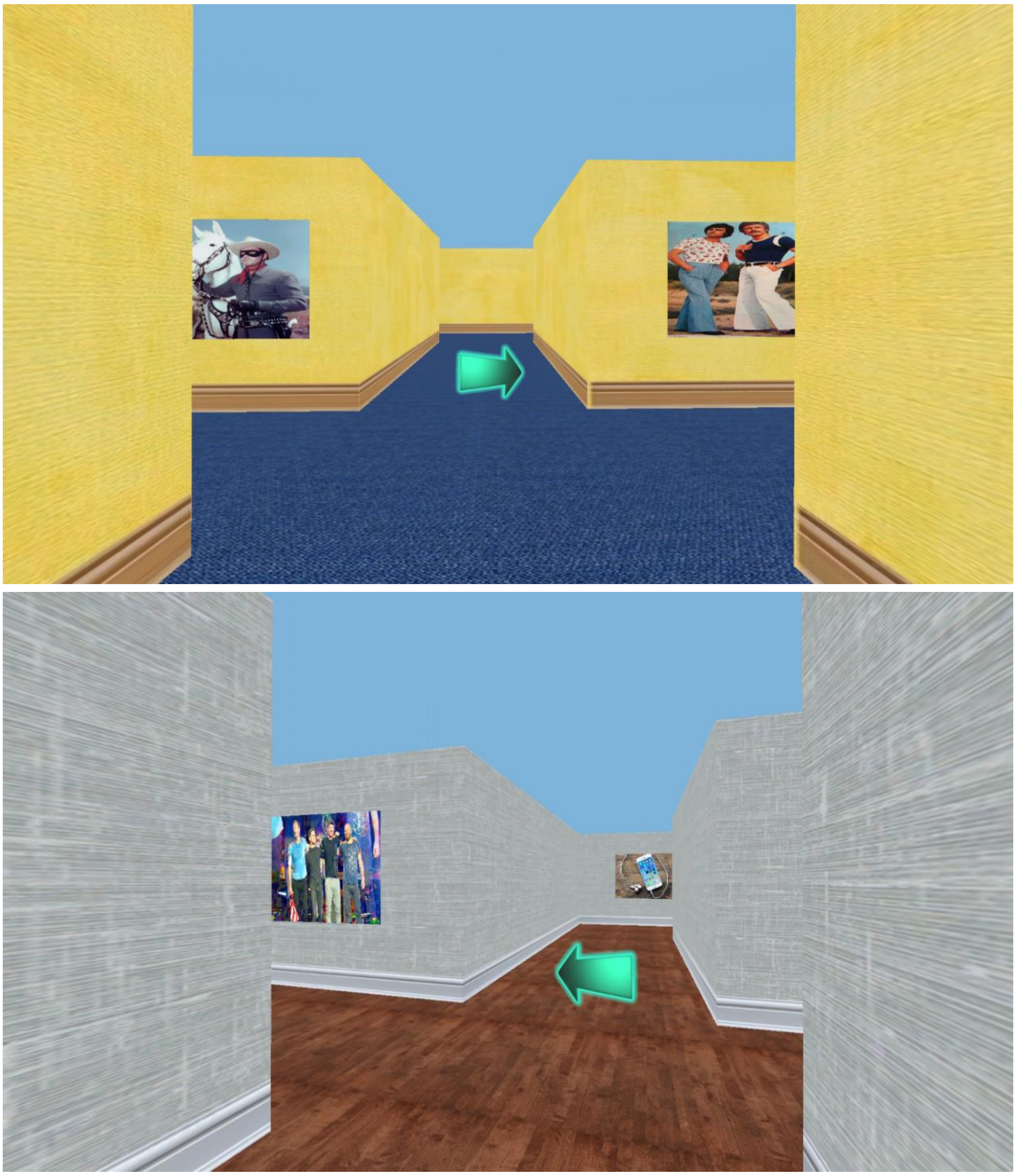
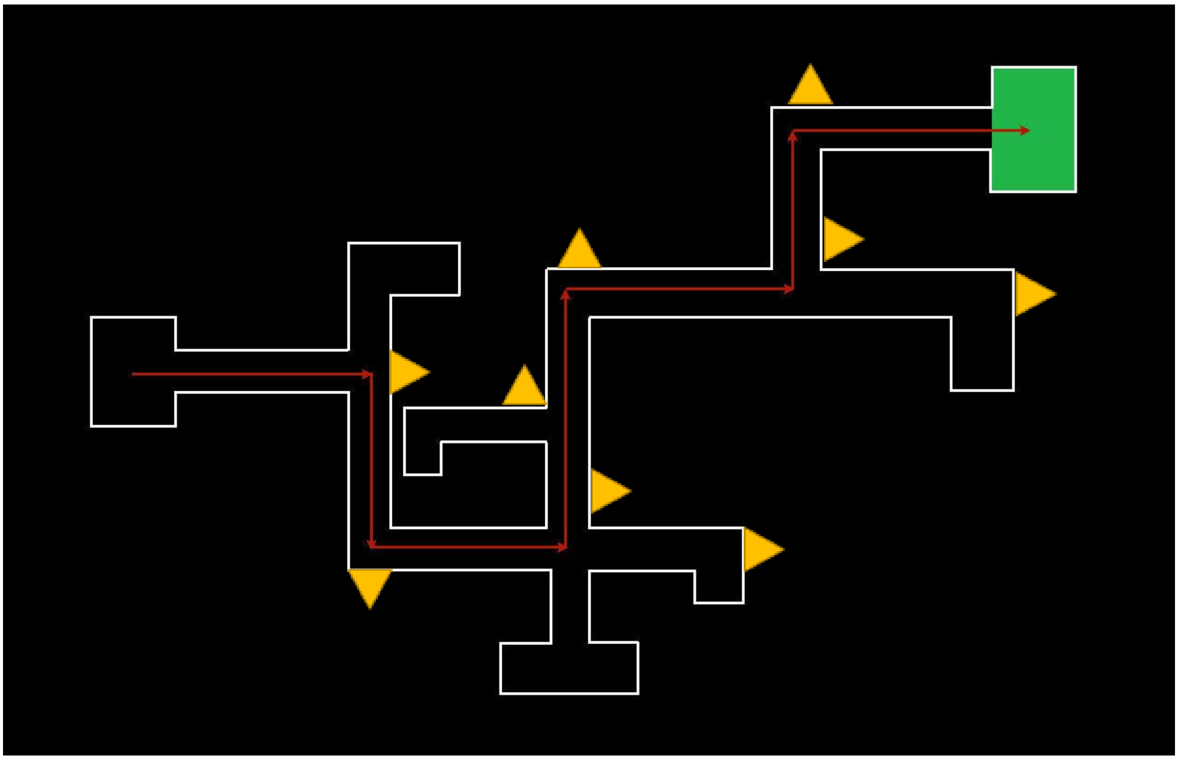


Figure 4.8

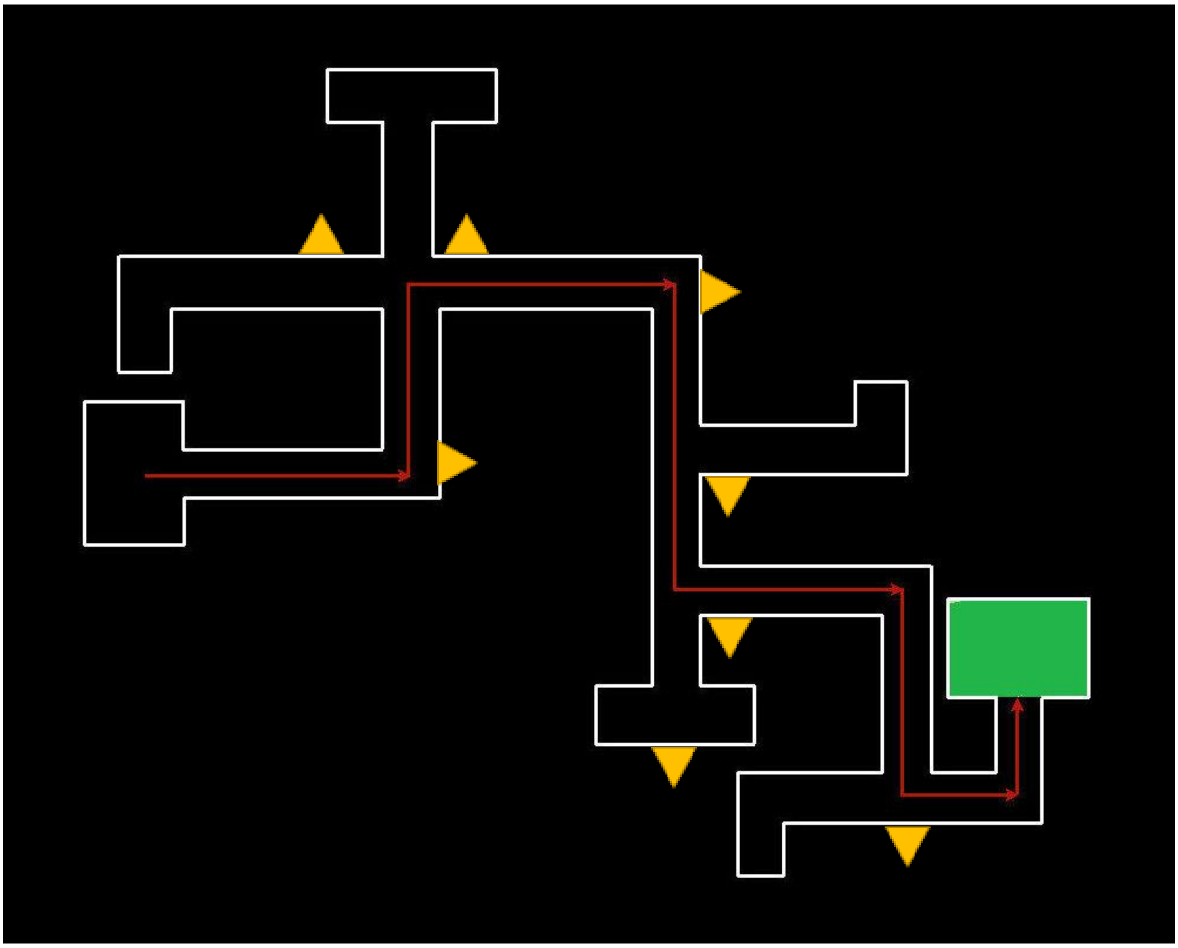
Route Map for the Experimental Route-Learning Task in Experiment 4.2



Note. Bird's eye view perspective of the route map and layout. The red arrows illustrate the specified route and the green box highlights the end destination. The yellow triangles highlight the position of the nostalgic or control pictures.

Figure 4.9

Route Map for the Experimental Route-Learning Task in Experiment 4.2



Note. Bird's eye view perspective of the route map and layout. The red arrows illustrate the specified route and the green box highlights the end destination. The yellow triangles highlight the position of the nostalgic or control pictures.

4.5 Commentary

I dedicate this commentary to my lived experience of running a clinical research trial during and after the COVID-19 pandemic.

The Impact of the COVID-19 Pandemic

Nine months had passed since I had received NHS ethics approval, and finally, the MARC team gave the green light. I could set-up the study at last—a study I would need to deliver after lockdowns and isolation. As MARC was based within a NHS trust, fortunately, the essential standard operating procedures and protective equipment were in place to make delivering the study possible. Throughout the 12-month long project, lateral flow tests, constant cleaning, and screening for COVID-19 symptoms became routine. For hours at a time, I wore full personal protective equipment with each participant in a fluid repellent face mask. These practices kept us safe but increased my workload, made communication more challenging, and lengthened the time taken to deliver the study.

Developing a Dementia-Friendly Virtual Environment

A key project-specific challenge I had to overcome was the development of a dementia-friendly, virtual-environment interface. Older adults are typically less accustomed to information and communication technology than the general population. I was also working with a clinically vulnerable population who were experiencing differing degrees of memory problems. I was acutely aware from the start that computers, a joystick, and virtual environment technology would feel foreign to my participant group. And indeed, I found this to be the case. During recruitment, the computer-element of the study deterred some individuals' from wanting to take part. All the participants' who did take part had no previous experience of virtual environments, and some had little to no computer experience at all.

The feedback I received during my PPI work in combination with academic and technical expertise, were incremental in the development of the virtual environment.

During the first phase of my PPI work, a volunteer (without a dementia diagnosis) trialled the route-learning task presented in Chapter 3. The individual found the visual appearance of the virtual environment unrealistic and intimidating. The paths felt long and challenging, and they felt that a person with dementia may struggle to concentrate for that period of time. Midway through the task, the volunteer fell through the virtual environment walls, highlighting the need to create a more naturalistic environment with design modifications that would limit disorientation. In response, our research team amended the environmental design: (1) we applied life-like interior decor, (2) we shortened the length of the route, and (3) we narrowed the visual field to prevent collisions. The end result depicted a hallway in a welcoming house, which included a series of passageways and junctions. I gathered feedback on the new and improved virtual route during the second phase of my PPI work. Two volunteers successfully completed task. They recommended that four training trials should be sufficient. They also voiced a preference towards navigating with a joystick rather than a gamepad. In addition, the academic team raised an important issue—that apart from the pictorial nostalgia induction, the design of the two virtual environment was identical and could cause participants' to confuse one environment with the other. To address this, we designed two distinct virtual environments for each route-learning task. That is, one virtual environment contained a blue carpet and yellow wallpaper, and another depicted a wooden floor and grey wallpaper.

Implementing a joystick training session at the first (and second) visit played a key role in the success of route-learning task. The training session gave participants' the opportunity to get a taste for what the tasks were like. They could gauge how their physical bodies would react (e.g., do they feel nauseous? does virtual movement trigger motion sickness?). I found it best to introduce the technology in a relaxed manner and provide encouragement throughout (e.g., praise and pointers to assist movement). It was rewarding to watch individuals' who felt apprehensive beforehand perform well. Out of the 28 participants I recruited, most successfully completed the training. All the participants who continued in the study (i.e., attended visit one and two) successfully completed the two more challenging route-learning tasks. The tasks, however, did present their quirks. One participant, for example, thought the green arrows were tokens that needed to be collected during navigation. Another participant reached the end of the virtual route and instead of navigating toward the end box, they turned around and began to retrace their steps. I had to carefully observe participants' activity during the task to detect scenarios such as these, and provide further guidance when needed. Some participants evinced more errors than others, and generally, found the task more challenging. For these participants', they simply needed more guidance and practice before navigating independently. In consultation with the academic team, we decided to increase the number of training trials from four to a minimum of four and a maximum of eight trials. This gave participants' more time to grasp the task. A real advantage of the within-subjects design was that we could adapt the training trials to each person without obscuring the results.

This experience taught me the value of PPI work. The skills I had gained helped me delivery the study. I learnt how being adaptable and responsive to participants' feedback is critical for bettering their research experience, and in turn, reduces the likelihood of missing data and study withdrawals, and in all, produces better quality data.

My Personal Experience of an Idiographic Pictorial Nostalgia Induction Procedure

In the study, I had the pleasure of working with a fascinating, kind, and committed group of individuals'. I learnt how, for most, participation in research is one way to be a part of a collaborative effort towards improving the lives of people affected by dementia. Without doubt, the interview and picture reveal was one of the highlights of my journey. It was a joy to hear about each individuals' past life, stories, and adventures. I felt transported back in time to an era I had never experienced. I developed a deeper understanding of who they were. I got a sense of the world they had experienced as a child, and then, a grownyoung-adult. Out of 210 nostalgic pictures I selected, only a handful were the same. The most popular being the Beatles. Among others were the ole box TVs, Radio Luxembourg, Journey into Space, Lone Ranger, and Newquay harbour (Cornwall, UK).

After one of the interviews, I vividly recall the words of one participant. They voiced how refreshing it was to talk about their past with someone new. Socialisation had become challenging, with it being more and more difficult to remember what they did yesterday, or in the past week. But when talking about events further back in time, they found conversation flowed and it did so with ease—a talkative, passionate and enthusiastic individual sat in front of me. Hearing this, highlighted to me the benefits of steering the conversation towards meaningful nostalgic memories. When short term memories feel foggy, I saw how therapeutic it can be to draw upon memories which are crystal clear.

At the end of the study, a participant likened the virtual experience to a "photo album of their life." The path unfamiliar but lined with pictures they knew. Participants' mostly responded positively to the picture reveal, and in some cases, neutrally. One individual did report feeling disconcerted. Given that the induction procedure was concealed from participants', when the personal pictures were encountered it came as a surprise. Understandably, the memories they had shared with me several weeks prior were not in the forefront of their minds, so to view a selection of personal pictures was puzzling. The study debrief helped to address this. It gave me the opportunity to explain the underlying aim (i.e., evoke nostalgia), the methodological approach used, and why. Participants received a written copy of the copyright owners of the pictures. At first, I felt this task added to what was already a time intensive study, but it is a step I am thankful for. I had not anticipated the positive responses it would receive. Participants' had spent hours taking part in my study and at the end I felt I had something meaningful to give back to them.

Chapter 5: General Discussion

In this chapter, I first summarise the key findings of each chapter and incorporate other theoretical perspectives to the regulatory model of nostalgia. Next, I discuss the limitations and directions for future research. I then address the methodological, theoretical, and applied implications of my work.

5.1 Summary of Findings

Spatial anxiety negatively influences navigation performance (Coluccia & Louse, 2004; Hund & Minarik, 2006; Walkowiak et al., 2015). Thus far, researchers have only measured spatial anxiety using self-report questionnaires (Lawton, 1994, 1996), limiting further investigation into its causal effects. In Chapter 2, I begin by developing a novel induction procedure for spatial anxiety. In one experiment, participants navigated a virtual environment using directional arrows. I then removed the arrows and participants either navigated the same route (control condition) or a route in which I surreptitiously implemented a disorientating experience by introducing unfamiliar paths and landmarks (spatial-anxiety condition). The induction procedure effectively induced transient spatial anxiety and task stress but did not significantly lower task enjoyment. This work validated a methodological protocol for manipulating spatial anxiety.

Nostalgia counteracts adverse psychological and environmental conditions (Sedikides et al., 2015; Wildschut & Sedikides, 2022, in press). In Chapter 3, I investigated whether nostalgia would counteract spatial anxiety (i.e., feelings of apprehension and fear about navigating everyday environments). Specifically, the regulatory model of nostalgia proposes that the emotion serves as a homeostatic corrective: adverse conditions trigger nostalgia, and, in turn, nostalgia restores equanimity by counteracting these negative states (Sedikides et al., 2015; Wildschut & Sedikides, 2022, in press). I conducted three experiments that tested the regulatory model of nostalgia in relation to spatial anxiety. According to this model, spatial anxiety would evoke nostalgia, and nostalgia, in turn, would alleviate spatial anxiety. In Experiment 3.1, I administered the spatial-anxiety induction from Chapter 2 and found that spatial anxiety triggered nostalgia. In Experiment 3.2 and 3.3, I embedded a pictorial nostalgia induction within a virtual route-learning task. The nostalgic (versus control) pictures reduced spatial anxiety in both a passive (via video clip) and active (via computer-based) navigation task. Additionally, Experiment 3.3 provided evidence for nostalgia's beneficial downstream effects in that nostalgia-induced reductions in spatial anxiety were related to higher goal setting (i.e., individuals were more willing to take on a more challenging [versus easy] future spatial task).

The regulatory model of nostalgia is broadly consistent with other theoretical approaches. The undoing hypothesis, which forms the basis of the regulatory model, stipulates that positive emotions serve a restorative feedback mechanism to help facilitate a neutral psychological homeostasis (Fredrickson & Levenson, 1998). The premise that adverse, negative states are countered by positive ones aligns with recent theoretical advances such as, the after-effects of self-control on reward responsivity (Kelley et al., 2019). Kelley and colleagues (2019), for instance, outline how the act of exerting self-control (i.e., one's ability to change a motivated response) is aversive, which then activates the reward system and reward-related impulses (e.g., food, sexual attraction, money) as a way to regulate one's emotional state. This viewpoint assumes that, generally, individuals maintain a mild, positive state. However, exerting self-control is taxing and triggers a negative emotional state. Similar to the regulatory model a positive-laden response becomes activated. In Kelley et al. case, they propose that reward responsivity becomes heightened, which in turn, decreases the threshold for pursuing reward-related actions and thus, increases attention and motivation toward rewarding stimuli. Receiving the reward (e.g., food) generates positive emotions which counter the negative ones associated with exerting self-control. Kelley et al. (2019) theoretical stance was influenced by Solomon's (1980) earlier opponent-process theory of motivation. Solomon (1980) states that fluctuations in affective states over time are driven by the fundamental motivation to maintain homeostasis and balance. Corroborating Fredrickson and Levenson (1998) undoing hypothesis and the regulatory model of nostalgia.

In addition to alleviating adverse psychological and environmental conditions, nostalgia boosts a number of psychological resources (Dodd et al., 2022; Ismail et al., 2018; Ismail et al., 2022; Routledge, 2015; Sedikides & Wildschut, 2018; Sedikides et al., 2015). In Chapter 4, I focus on the potential psychological benefits of nostalgia in a spatial context. I also transition from a young, student sample to an older adult and clinical group. In Experiment 4.1, I piloted a nostalgic picture manipulation among healthy adults. To do this, I selected nostalgic pictures that reflected the decade during which healthy adults lived most of their childhood. Then, in Experiment 4.2, I applied and adapted the nostalgia manipulation to people living with AD. Among people with AD, I personalised the pictures to their specific and meaningful past memories. In both experiments, nostalgic (compared to thematically matched control) pictures successfully evoked nostalgia and boosted psychological resources including: social connectedness, self-continuity, meaning in life, self-esteem, and positive affect. Among people with AD, nostalgic pictures enhanced picture recognition, but not spatial memory. Typically, AD impairs landmark recognition (Monacelli et al., 2003). Cherrier et al. (2001), however, reported that memory surrounding the identity of landmarks is still relatively preserved. In a real world setting, memorabilia and personal pictures have been shown to help people with dementia recognize their own rooms (Namazi et al., 1991; Nolan et al., 2002). Spatial memory (i.e., recalling directional decisions) is arguably more challenging than recognition, which was reflected by the low, skewed spatial-memory scores. This, combined with the difficulties associated with navigation in AD (Cushman et al., 2008; delpolyi et al., 2007; Kavcic & Duffy, 2003), raises the likelihood that spatial-memory evinced a floor effect.

5.2 Limitations and Future Directions

I first acknowledge a number of limitations specific to the spatial-anxiety manipulation. The induction procedure successfully triggered spatial anxiety. However, I cannot rule out the possibility that the procedure also heightened general anxiety. Domain-specific anxiety constructs, such as spatial anxiety, are moderately correlated with general anxiety (Alvarez-Vargas et al., 2020, McKheen, 2011), but this overlap in variance is predominately explained by genetic rather than environmental factors (Malanchini et al., 2017). Regardless, an important next step for future research is to investigate the specificity of the spatial-anxiety manipulation by clarifying whether its effects are uniquely attributed to spatial, and not general, anxiety. Future studies should employ measures of general anxiety. For example, the 7-item Generalised Anxiety Disorder Scale (Lowe et al., 2008) is a widely used and validated measure of anxiety in both general and clinical populations (Spitzer et al., 2013). A future study would do well to control for general anxiety using reliable self-report measurements. The addition of objective physiological parameters such as heart rate, heart rate variability (Howell & Hamilton, 2022), and skin conductance levels (Murty et al., 2011) would also strengthen the study findings and deepen our understanding of the physiological effects of spatial anxiety.

Another important consideration is that the spatial anxiety manipulation is a composite involving (1) a more challenging maze route and (2) a disruption to pairings between learnt cues and associated turns at junctions. Future work must address whether spatial anxiety results from altering the maze complexity, breaking down the cue pairings, or both. To achieve this, I envisage developing an alternative spatial-anxiety condition that would involve re-designing the layout and route of the virtual environment. In this new condition, the maze route could solely disrupt the association between learnt cues and turns at junctions, whilst controlling for maze complexity. In the current composite manipulation, the two design modifications occur between the fifth and ninth turning point within the virtual maze during the spatial-anxiety condition test trial. Within this section of the route, maze complexity increases by introducing eight additional path segments and five dead-end paths. To remove maze complexity from the manipulation, these paths could simply revert back to the route encountered during the training trials and control condition test trial. With the route length controlled, the pairings between cues and turns at junctions could be disrupted by inverting the route. In other words, the turn response associated with a cue would reverse. For instance, see Figure 2.2, the first decision point is located at a T-junction with a cue in frontal view. During the training trials, a navigator learns to turn right at the cue. If the route becomes surreptitiously inverted during the new spatial-anxiety test trial, the decision point would then require a left turn response. At the second decision point, the inverted route would transform a turn right response to a turn left, and again, disrupt the associated cue pairings. A future study would do well to compare the effect of the composite manipulation and a manipulation that alters only one out of the two design modifications (i.e., cue pairings) on spatial anxiety. This would help identify the design modification accountable for triggering spatial anxiety.

Another limitation relevant to Chapter 2, is that the sample of participants that completed the spatial-anxiety manipulation mostly included female, Caucasian, UK-based, university-aged students—a sample which falls into the category of Western, Educated, Industrialized, Rich, and Democratic (WEIRD) societies (Henrich et al., 2010). Future work would therefore do well to test the strength of the spatial-anxiety induction across a more diverse population to examine its generalizability. Gender differences are noted in terms of trait-level spatial anxiety, with females exhibiting higher levels of spatial anxiety than males (Lawton, 1994, 1996; Lawton & Kallai, 2002; Schug, 2016). Females generally experience greater real or perceived safety threats than males, which influences their cautious tendency towards navigation. For example, females are more likely to explore familiar places that are closer to home (Gagnon et al., 2018). This increased awareness to possible threats can heighten apprehension about travelling new spaces alone (Lawton & Kallai, 2002). Lawton and Kallai (2002) found that across both American and Hungarian samples, females reported higher spatial anxiety than males. Whereas, in a sample of older adults (Davis & Veltkamp, 2020), gender differences in spatial anxiety disappeared, indicating that as males age spatial anxiety increases to the level experienced by females. Future studies could compare the effect of the spatial-anxiety induction on gender, as well as individuals from varied age groups and cultures.

In Chapter 3 and 4, the pictorial nostalgia induction was completed by a broader participant sample, including younger and older adults, as well as individuals with AD. Navigation difficulties are not only observed among people with dementia but also present in other neurological conditions, such as epilepsy, stroke, topographical disorientation disorders, and developmental coordination disorders (Aguirre & D'Esposito, 1999; Barrett & Muzaffar, 2014; Cimadevilla et al., 2014; Iaria & Barton, 2010; Monacelli et al., 2003; Vaivre et al., 2011). Future studies would do well to investigate whether pictures that evoke nostalgia provide the same beneficial effects for people with other types of dementia (e.g., vascular dementia, Lewy body dementia, a mixed form of dementia types, or posterior cortical atrophy; McKeith, 2002; Román et al., 1993; Yong et al., 2018) and neurological disorders. I would expect nostalgia to offer psychological benefits regardless of the clinical diagnosis.

I next acknowledge the limitations specific to the nostalgic-picture induction. In Experiment 3.2 and 3.3, the nostalgic picture content only incorporated several themes (i.e., popular TV shows, films, and musicians). I subsequently addressed this by introducing a greater number and variation of themes in Experiment 4.1 (i.e., technology, transport, Royal Family events, comedians, and sporting icons) and Experiment 4.2 (i.e., places, fashion, and loved ones and important events). To begin with, I followed a nomothetic approach to the induction procedure by tailoring general stimuli and principles (e.g., popular culture) to a particular cohort (Dimitriadou et al., 2019). Among the younger student sample (Experiment 3.2 and 3.3), the nostalgic pictures dated back five years or more from the time of the experiment. Among the older adults (Experiment 4.1), I generated picture content specific to the decade (i.e., 1950s, 1960s, 1970s) during which they would have lived most of their childhood. Although childhood memories are a central feature and source of nostalgia (Hepper et al., 2012), the picture content did not capture the highly personal aspect of the emotion (Sedikides & Wildschut, 2018). Other nostalgia induction procedures allow the individual to select their own meaningful songs (Cheung et al., 2013) or recall unique past experiences (i.e., ERT; Sedikides et al., 2015; Wildschut et al., 2006). Because of this, and the feedback received during my Patient and Public Involvement work, I further developed the induction procedure in Experiment 4.2 by employing an idiographic approach. Specifically, I enhanced the personal relevance of the pictures by collating images that represented an individual's unique autobiography. Personalising images to individual memories was effective. In fact, state nostalgia was highest when pictures reflected the individual's past (Experiment 4.2), in comparison to pictures associated with a more general time-period (Experiment 3.2, 3.3, and 4.1), suggesting that an idiographic approach increases nostalgia's potency. I recognise that this is speculative given the many differences between experiments; the difference between nomothetic and idiographic inductions of nostalgia is an important direction for future research (Dimitriadou et al., 2019; Zhang et al., 2022). A key drawback of the idiographic nostalgia-induction procedure was its time intensive nature, which amounted to approximately five hours per participant. I realize that this would be impractical for larger experimental studies, but I hope my personalised approach in harnessing nostalgia inspires clinical interventions.

Throughout my research I utilised life-like virtual environment technology. Virtual environments can be designed and personalised in such a way to visually represent settings in the real world, with the advantage that the platform itself is safe, can be easily controlled and poses minimal harm to the user (Lokka et al., 2018). Past research has successfully manipulated emotions within virtual environments, including sadness, fear, relaxation, and joy (Baños et al., 2012; Felnhofer et al., 2015; Riva et al., 2007). I broadened this work and effectively triggered both spatial anxiety and nostalgia within a virtual platform. Although virtual environments provide visual input, one key limitation is that they lack vestibular, proprioceptive, and efferent information that one would receive in real-world navigation. Despite this, virtual environments are an ecologically valid tool given that the acquisition of spatial knowledge is comparable to real-world navigation (Coutrot et al., 2019; Cushman et al., 2008; Hegarty et al., 2006; Ruddle et al. 1997; Richardson et al., 1999). Van der Ham (2015) examined navigation performance across virtual versus real-world environments, and a hybrid environment (i.e., a combination of the two). Out of the three environments, the optimal condition was dependent on the type of navigation task. That is, when a task assesses landmark or route knowledge (such as in the current Experiments) either of the three options suffice. Whereas, for survey knowledge, a real-world environment is superior. Another avenue for future research could be to examine if nostalgia's beneficial effects apply to other life-like virtual surroundings (e.g., indoor residences, outdoor urban landscapes; Davis et al., 2017), real-world environments (Nolan et al., 2002), or a combination of the two (van der Ham et al., 2015). Although real-world environments are the most ecologically valid option, these settings are costly and pose restrictions in terms of control over the route layout and landmarks characteristics. Across the UK, however, several healthcare organisations have turned to nostalgia to create calming spaces for people with dementia. NHS hospitals have instilled dementia wards with vintage seaside themes, old fashioned telephone boxes, cinema booths, or 1950s-themed memory rooms (Brewis, 2019). A future study could utilise pre-existing environments with nostalgia-infused design to examine and scientifically test its psychological benefits. In a re-designed hospital setting, a healthcare staff member reported that patients surrounded by meaningful and stimulating activities were more likely to sleep better and were less likely to fall and feel agitated (Brewis, 2019). As well as testing beneficial psychological effects, a real-world study could investigate the effects of nostalgia-infused design on physical health behaviours (e.g., sleep, agitation, and falls risk).

5.3 Implications

The current findings have methodological, theoretical, and applied implications. My research adds several methodological contributions. First, I provide a novel protocol for inducing spatial anxiety. Thus far in the spatial navigation literature, researchers have administered context-irrelevant stressors (e.g., the Trier Social Stress Test; Toet et al., 2009, and threat of shock technique; Cornwell et al., 2012) to examine the impact of acute anxiety or fear on navigation. Here, I validate a direct experimental manipulation of spatial anxiety within a virtual environment. This contribution enables future researchers to adopt experimental paradigms, which could help untangle the causal relationship between spatial anxiety and navigation ability, as well as uncover potential mediators. For example, future studies could assess the effect of spatial anxiety on related constructs such as motivation to explore, navigation experience, strategy preferences, and spatial confidence (Hegarty et al., 2023; Hund & Minarik, 2006; Picucci et al., 2011).

Second, I provide a new pictorial nostalgia induction and evidence its effectiveness across different age groups, as well as a clinically vulnerable population. Throughout life, people collect photographs, keepsakes, and memorabilia surrounding momentous life events and special memories with loved ones (Hepper et al., 2012). In the current research, I gathered general and specific nostalgic stimuli that related to popular culture, objects, and scenes. As it stands, the most widely used nostalgia induction technique is the ERT (Sedikides et al., 2015; Wildschut et al., 2006). The procedure instructs participants to recall either their most nostalgic experience (nostalgia condition) or an ordinary past event (control condition). The task sparks vivid autobiographical recall, which is an effective trigger of emotions, particularly ones with high personal relevance (Joseph et al., 2020). Other scholars, however, have critiqued the ERT and claim that the task “selectively privileges” positive features of the emotion because participants are instructed recall their most nostalgic experience (Newman et al., 2020, p. 342). However, Zhou et al., (2022) adapted the ERT by instructing participants to recall a typical (rather than their most) nostalgic experience and nostalgia continued to elevate happiness levels and positive affect. Another important consideration is that the original ERT raises not only positive, but also, negative affect after a nostalgic induction (Frankenbach et al., 2021; Leunissen et al., 2021). I acknowledge that developing multifaceted content for nostalgia inductions strengthens the validity of causal inferences. Researchers have addressed this by generating various modalities for inducing nostalgia, such as scents (Reid et al., 2015), music (Barrett et al., 2010), photographs (Yang et al., 2021), and prototype features (Hepper et al., 2012). I diversified the methodological toolbox by adding a novel nostalgia induction within an interactive virtual scene.

In my work, I cover new theoretical ground and expand the regulatory model of nostalgia to the spatial domain. It has been established that nostalgia counters a number of negative psychological states, such as disillusionment (by fostering meaning in life; Maher et al., 2021) and loneliness (by fostering a sense of social connectedness, secure attachment, and interpersonal competence; Wildschut et al., 2006). The emotion also helps to provide comfort when one is exposed to adverse environmental conditions, such as cold temperatures (by raising subjective warmth; Zhou et al., 2012) and harsh, stormy weather (by alleviating weather-induced distress; Van Tilburg et al., 2018). In my research, I introduced a new environmental threat: spatial anxiety—a negative experience involving apprehension and disorientation during navigation which arises from one’s actual or perceived inability to master it (Lyons et al., 2018; Malanchini et al., 2017). A next step for future research could be to further expand the regulatory model to include other conditions that could thwart environmental mastery, such as impairments to vision or hearing.

This research serves broad applications in spatial, social, and clinical domains. The spatial-anxiety induction has the potential to advance experimental research on the relation between spatial anxiety and navigation, as well as help to identify underlying mechanisms. In turn, this may inform the development of training programs (Lovden et al., 2011; Uttal et al., 2013) and targeted, domain-specific interventions (Malanchini et al., 2017). Enhancing spatial skills, especially for spatially anxious navigators, could diversify involvement in fields where strong spatial ability is a common prerequisite for success (e.g., STEM; Kell et al., 2013; Wai et al., 2009). Moreover, better understanding the causal effects of spatial anxiety on navigation may offer further insight into the difficulties faced by individuals with impaired navigation, such as people with AD (Chiu et al., 2004; Davis & Veltkamp, 2020; Mahoney et al., 2000).

Successful navigation is crucial for everyday functioning, socialisation, and overall wellbeing. Becoming spatially disorientated and lost in everyday environments has negative practical and emotional consequences (Lynch, 1960; Carlson et al., 2010), highlighting the importance of interventions that support populations with such difficulties. Environmental guidelines recommend introducing landmarks that are distinct and memorable to aid navigation (Caduff & Timpf, 2008; O'Malley et al., 2017). The current research demonstrates that nostalgic (versus non-nostalgic) landmarks assuage spatial anxiety among non-clinical populations and serve psychological benefits for older adults with and without dementia. Installing nostalgic objects within existing facilities is a cost-effective and easy-to-implement strategy. Various organisations and researchers have developed audit tools to help create dementia-friendly spaces including 'Enhancing the Healing Environment Assessment Tool' (The King's Fund, 2013) and 'Dementia Audit

Tool' (Dementia Services Development Centre, 2011). Both tools advise using landmarks that are colourful and interesting to assist with navigation (e.g., plants, furniture, wall hangings, and artwork). Design guidelines and audit tools should consider incorporating scientific evidence surrounding landmarks that confer beneficial psychological effects, such as nostalgia.

In the later stages of dementia, a person often transitions from a home environment into residential care, which particularly challenges their sense of belonging and connection to their environment (Førsund et al., 2018). Fleming and Bennett, and Zeisel et al. (2015, 2020) dedicate one of their core design principles to creating a place that is familiar for a person with dementia. That is, the environment should reflect the individual's personal background and include them in the process of personalising the space. This could entail infusing the environment with features, cues, or props (e.g., photographs, paintings, objects, furniture) that enhance a sense of identity, trigger memories and connect the individual to their past self. In my research, I personalise virtual design features using pictures that reflect the unique memories of people with AD. I demonstrate that nostalgia-infused landmarks enhance self-continuity, thus, meeting Fleming and Bennett's (2015) design goal. In addition, nostalgic landmarks boosted social connectedness, meaning in life, self-esteem, and positive affect. Applying nostalgia to environmental settings could help guide the personalisation of spaces and assist professionals (i.e., architects, designers, health care staff, and relatives) with addressing key dementia design principles (Gramegna, 2022).

In care home settings, new residents are strongly encouraged to bring personal items, especially those that hold sentimental value (van Hoof et al., 2017). Private rooms within shared living accommodation allow the individual to truly personalise their space, and therefore, is where the personal aspect of nostalgia could function at its highest. Harnessing this within communal spaces may become more challenging because areas are shared by people with diverse backgrounds and life histories. To address this, each resident could incorporate one personal nostalgic item into a given communal area (e.g., living room, dining area, garden). Older adults with memory difficulties value a space with relevant pictures that evoke emotion but also spark conversation (O'Malley et al., 2018). Instilling personal nostalgic pictures from numerous residents within a shared space may encourage social interaction. Signage companies (i.e., New Vision) have produced interchangeable picture display systems. For example, the system, ‘Picture This,’ comprises a wall-mounted picture with a support panel, which allows pictures to be changed easily to help personalise and refresh artwork within care home and hospital environments (Edwards, 2023). Utilising real-world products such as this, whilst cultivating nostalgia, may help achieve meaningful yet interactive design.

Nostalgic pictures offer other clinical benefits. A person-centred care approach embodies treating a person with dementia individually and understanding their lived experience of dementia. This may include their stories, passions, and idiosyncrasies—all of which help to reaffirm the self (Brooke, 2003; Kitwood, 1997). For example, installing digital photos albums for care home residents improved person-centered communication with staff (Williams et al., 2011). Social interactions increased from 5 to 15% in the two weeks following photographic installation. In the real-world, home care and support organisations advertise the use of nostalgia prompts (e.g., scrapbooks, memory boxes, music, tangible items) to assist the delivery of high-quality care (Carefour, 2021). Irish (2022) developed a toolkit to enhance the quality of life of a person with dementia experiencing anhedonia (i.e., a loss of pleasure or enjoyment in daily activities). The toolkit outlines various simple strategies to help carers’ support people with dementia. One of these strategies is to “Revisit the past” using activities, objects, and music from childhood and/or early adulthood to elicit nostalgia, and in turn, help motivate and energise the person. Identifying personal nostalgic triggers could therefore assist the delivery of person-centred care, communication, and pleasure in daily life.

Older adults value being included in the process of selecting personal items (van Hoof et al., 2017). In Chapter 4, although the pictures were personalised to the childhood years and memories of middle-aged older adults, I selected the imagery on behalf of these individuals to conceal the nostalgia manipulation, and thus, prevent bias. Applying the nostalgia intervention from a research setting into practice would therefore require adaptation. Explicitly stating the aim (i.e., to create nostalgia-infused landmarks that reflect past memories) would allow the person with dementia and their caregiver to be more actively involved in the selection process. Welsh et al. (2018) adopted a similar approach when developing a smartphone application to support meaningful conversations between younger and older generations. The app, 'Ticket to talk,' encouraged younger adults to create a personal digital profile for a person with dementia. Prompts such as, "Steven was 18 in 1940. Can you find a picture of London at that time?" guided the selection of media content (e.g., pictures, YouTube videos), which then served as a visual aid during social interactions. A challenge of the pictorial nostalgia induction procedure was my inability to validate the potential nostalgic images with the person during the selection process. In practice, one could directly clarify with the individual the features of a memory and the corresponding picture. This could enhance the intervention further, not only in terms of ensuring the image accurately reflects their past but also serves as a meaningful, social activity. Going forward, a co-productive approach could guide this development. Co-production combines the person with lived experience and knowledge, with clinical and academic expertise to enhance a healthcare intervention (Tummers et al., 2016). This collaborative approach has been growing in the dementia field (Hales & Fossey, 2018). Dodd and colleagues (2022), for example, co-produced a workbook for a person with dementia and their caregiver. Eight public contributors with mixed lived experiences of dementia consulted the research team across five face-to-face meetings prior to testing. A successful, participant-led intervention emerged, which integrated nostalgia into day-to-day conversation. Adopting a co-productive approach, such as this, could help transform the pictorial nostalgia manipulation into a real-world design intervention.

As well as supporting dementia design and care, nostalgic pictures may apply to therapy-related practices. The nostalgia workbook developed by Dodd et al., (2022) indicated that photographs were the most frequently used aid to trigger nostalgic discussions. Early on, therapists have used photographs as external memory aids for people with dementia (Sandoz, 1996; Weiner & Abromowitz, 1997), serving as a "non-verbal catalyst" to "bring forth feelings and memories" (Weiser, 2004). In reminiscence activities, sensory objects are utilised to trigger the past (Huber et al., 2019; Kaminsky, 2014). Although reminiscence therapy is a widely adopted intervention that aims to improve the quality of life and outcomes of people with dementia, scientific findings are inconsistent (Woods et al., 2018). Typically, reminiscence focuses on the process of recall, which can led to both ordinary and nostalgic memories (Coleman, 2005). Nostalgia, in contrast, is sourced from memories that are affect-laden, personally-relevant, and meaningful (Sedikides et al., 2004; Ismail et al., 2022). As demonstrated here, and in other studies (Dodd et al., 2022; Ismail et al., 2018; Ismail et al., 2022), nostalgia boosts the psychological resources of people with dementia. Interventions with a focus on cultivating nostalgia, rather than general reminiscence, could therefore be a promising avenue for therapy development.

5.4 General Conclusion

In Chapter 2, I provided a novel experimental induction of spatial-anxiety that will facilitate future research on the causal effects of spatial anxiety in the navigation domain. I applied this induction procedure in Chapter 3 and demonstrated that spatial anxiety triggers nostalgia. Additionally, I provided a new pictorial nostalgia induction and found that, when encountered in a virtual environment, nostalgia reduces spatial anxiety. I extended the utility of the regulatory model of nostalgia and illustrated how individuals use nostalgia to maintain equanimity when feeling spatially anxious. Chapter 4 further developed the pictorial nostalgia induction, which boosted psychological wellbeing and enhanced the recognition of landmarks for people living with AD. My research diversifies the methodological toolbox, contributes to theory, and offers broad and valuable real-world applications.

Appendix A

Questionnaires Used In Chapter 2

State Spatial Anxiety Scale

This questionnaire describes a number of situations that you can find yourself in. Read each description and then rate how anxious it makes you feel. Indicate to what extent you feel this way RIGHT NOW, that is, AT THIS PRESENT MOMENT. Write your answer in the blank space preceding each description, using the following scale:

1	2	3	4	5
Not at all anxious				Very anxious

_____ Deciding which direction to walk in an unfamiliar city or town after coming out of a train/bus/metro station or parking garage.

_____ Finding my way to an appointment in an unfamiliar area of a city or town.

_____ Leaving a store that I have been to for the first time and deciding which way to turn to get to a destination

_____ Finding my way back to a familiar area after realizing I have made a wrong turn and become lost while traveling.

_____ Finding my way in an unfamiliar shopping mall, medical centre, or large building complex.

_____ Finding my way out of a complex arrangement of offices that I have visited for the first time.

_____ Trying a new route that I think will be a shortcut, without a map.

_____ Pointing in the direction of a place outside that someone wants to get to and has asked for directions, when I am in a windowless room.

Task Experience

The following statements refer to the maze task that you completed.

Please indicate how much you agree or disagree with each statement by placing a number in the blank space preceding each statement, using the scale below.

1	2	3	4	5	6
Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree

The maze task....

___ was enjoyable

___ was fun

___ was exciting

___was easy

___ was boring

___ was tedious

___made me stressed

___made me anxious

___made me frustrated

___made me doubt my ability

___ was difficult

___ was something I would like to do again

___ was engaging

___was interesting

___ was something I am good at

Spatial Anxiety Scale

Please rate your level of anxiety when in the following situations. You should indicate your level of anxiety by placing a number in the blank space preceding each situation. The number could be anywhere from 1 to 5, according to the following scale:

1	2	3	4	5
Not at all anxious				Very anxious

_____ Deciding which direction to walk in an unfamiliar city or town after coming out of a train/bus/metro station or parking garage.

_____ Finding my way to an appointment in an unfamiliar area of a city or town.

_____ Leaving a store that I have been to for the first time and deciding which way to turn to get to a destination

_____ Finding my way back to a familiar area after realizing I have made a wrong turn and become lost while traveling.

_____ Finding my way in an unfamiliar shopping mall, medical centre, or large building complex.

_____ Finding my way out of a complex arrangement of offices that I have visited for the first time.

_____ Trying a new route that I think will be a shortcut, without a map.

_____ Pointing in the direction of a place outside that someone wants to get to and has asked for directions, when I am in a windowless room.

Spatial Anxiety Questionnaire

Please rate your level of anxiety when in the following situations. You should indicate your level of anxiety by placing a number in the blank space preceding each situation. The number could be anywhere from 1 to 5, according to the following scale:

1	2	3	4	5
Not at all anxious				Very anxious

_____ Finding your way around an intricate arrangement of streets.

_____ Directing somebody to a place of interest when standing in a windowless room

_____ Locating a vehicle in a very large car park or garage

_____ Having to complete a complex jigsaw puzzle

_____ Finding your way around an unfamiliar place

_____ Trying a new shortcut without using a map

_____ Following somebody's instructions to get somewhere

_____ Having to visualise a 3D object from a 2D drawing

_____ Having to rotate objects in your mind

_____ Finding a product in the local supermarket if the shelves have been rearranged

Appendix B

Materials Used In Chapter 3

B.1 Questionnaires Used In Experiment 3.1

Spatial Anxiety Manipulation Check

The following statements refer to how you feel right now. Please indicate the degree of your agreement or disagreement with each of the 3 statements listed below. You should indicate your agreement or disagreement by placing a number in the blank space preceding each statement. The number could be anywhere from 1 to 6, according to the following scale:

1	2	3	4	5	6
Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree

_____ Right now, I feel a bit lost.

_____ Right now, I have the sense of being lost.

_____ Right now, I feel disoriented.

Spatial Anxiety Scale

Please rate your level of anxiety when in the following situations. You should indicate your level of anxiety by placing a number in the blank space preceding each situation. The number could be anywhere from 1 to 5, according to the following scale:

1	2	3	4	5
Not at all anxious				Very anxious

_____ Leaving a store that you have been to for the first time and deciding which way to turn to get to a destination.

_____ Finding your way out of a complex arrangement of offices that you have visited for the first time.

_____ Pointing in the direction of a place outside that someone wants to get to and has asked you for directions, when you are in a windowless room.

_____ Locating your car in a very large parking lot or parking garage.

_____ Trying a new route that you think will be a shortcut without the benefit of a map.

_____ Finding your way back to a familiar area after realizing you have made a wrong turn and become lost while driving.

_____ Finding your way around in an unfamiliar mall.

_____ Finding your way to an appointment in an area of a city or town with which you are not familiar.

Nostalgia Inventory

The following statements refer to how you are feeling at this moment. Please indicate how much you miss from your past each of the 18 persons, situations, or events below. The best answer is what you feel is true at this moment.
Indicate your answer by using the rating scale presented below. Write the number in the space provided with each item.

1	2	3	4	5	6
I do not miss at all					I miss very much

_____ Family	_____ Feelings you had
_____ Not having to worry	_____ School
_____ Places	_____ Having someone to depend on
_____ Music	_____ Holidays
_____ Someone you loved	_____ The way society was
_____ Friends	_____ Pets
_____ Things you did	_____ Not knowing sad or evil things
_____ Childhood toys	_____ TV shows, movies
_____ The way people were	_____ Your house

State Nostalgia

The following statements refer to how you feel right now. Please indicate the degree of your agreement or disagreement with each of the 3 statements listed below. You should indicate your agreement or disagreement by placing a number in the blank space preceding each statement. The number could be anywhere from 1 to 6, according to the following scale:

1	2	3	4	5	6
Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree

_____ Right now, I am feeling quite nostalgic

_____ Right now, I am bringing to mind nostalgic experiences.

_____ Right now, I am having nostalgic feelings.

Positive and Negative Affect

The following statements refer to how you feel right now. Please indicate the degree of your agreement or disagreement with each of the 4 statements listed below. You should indicate your agreement or disagreement by placing a number in the blank space preceding each statement. The number could be anywhere from 1 to 6, according to the following scale:

1	2	3	4	5	6
Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree

_____ Right now, I feel happy.

_____ Right now, I feel in a good mood.

_____ Right now, I feel unhappy.

_____ Right now, I feel sad.

B.2 Questionnaires Used In Experiment 3.3

Nostalgia Manipulation Check

The following statements refer to how you feel right now. Please indicate your agreement or disagreement by placing a number in the blank space preceding each statement, using the scale below.

1	2	3	4	5	6
Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree

According to the Oxford Dictionary, 'nostalgia' is defined as a 'sentimental longing for the past.'

___ Right now, I am feeling quite nostalgic.
___ Right now, I am having nostalgic feelings.
___ I feel nostalgic at the moment.

Spatial Anxiety Measure

The following statements refer to the spatial navigation task that you just completed. Please indicate how much you agree or disagree with each statement by placing a number in the blank space preceding each statement, using the scale below.

1	2	3	4	5	6
Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree

During the navigation task, I felt...
___ lost
___ disoriented
___ adrift
___ like going around in circles

Spatial Anxiety Scale

Please rate your level of anxiety when in the following situations. You should indicate your level of anxiety by placing a number in the blank space preceding each situation. The number could be anywhere from 1 to 5, according to the following scale:

1	2	3	4	5
Not at all anxious				Very anxious

_____ Leaving a store that you have been to for the first time and deciding which way to turn to get to a destination.

_____ Finding your way out of a complex arrangement of offices that you have visited for the first time.

_____ Pointing in the direction of a place outside that someone wants to get to and has asked you for directions, when you are in a windowless room.

_____ Locating your car in a very large parking lot or parking garage.

_____ Trying a new route that you think will be a shortcut without the benefit of a map.

_____ Finding your way back to a familiar area after realizing you have made a wrong turn and become lost while driving.

_____ Finding your way around in an unfamiliar mall.

_____ Finding your way to an appointment in an area of a city or town with which you are not familiar.

Goal Setting

Next, you will complete another navigation task. You can choose to complete an easy or hard navigation task. Which one would you prefer? Please circle your choice.

I would like my next navigation task to be: EASY HARD

Picture Recall

When you were completing the navigation task, there were pictures on the wall of the maze. Below, please describe the pictures that you can remember. List as many as you can.

B.3 Additional Variables Recorded In Experiments 3.1 and 3.3

Experiment 3.1

Individual Difference Variables

Nostalgia proneness, rumination, regulatory mode, spatial ability.

Dependent Variables

Latency (i.e., time taken to navigate the maze), navigational errors, state version of the Behavioural Inhibition/Activation System (BIS/BAS) scale.

Control Variables

Familiarity with nostalgia, video game experience.

Experiment 3.3

Dependent Variables

Latency, directional landmark recall (i.e., recall of the direction participants had to turn at a series of landmarks and their confidence), nostalgia-related outcomes (i.e., positive affect, negative affect, self-esteem, self-continuity, social connectedness, meaning in life, optimism), competency (i.e., "during the navigation task… I felt" … "competent," "skilled," "in control," "efficient"), navigation task evaluation (i.e., "the navigation task was" … "enjoyable," "fun," "difficult," "boring"), a state version of the BIS/BAS scale.

Control Variables

Familiarity with nostalgia, video game experience.

Appendix C

Materials Used in Chapter 4

C.1 Patient & Public Involvement Work

Patient and Public Involvement work took place in two stages to help guide our research design. First, the researcher (AO) created an event for individuals who were part of the Senior Saints activity programme run by Age Concern. We created a booklet filled with pictures of old cars, comedians, fashion, movies, politicians, and sports heroes dated from 1940s to 1960s. The researcher (AO) and a voluntary research assistant gathered feedback on the pictures in order to establish whether participants recognised the pictures, and discussed with them if the picture brought back fond memories from the past or any feelings of nostalgia. We found distinct individual differences between the pictures for each pictorial theme. Most of the pictures were recognised. However, not all pictures elicited a fond memory. We concluded from the visit that pictures should be tailored to each individual if we wish to trigger nostalgia.

At the event, only one gentleman expressed interest in trialling the route learning task. He found the visual appearance unrealistic and intimidating (the walls were a grey concrete colour and the floor a patterned blue carpet). The length of the corridors was too long and he felt it could be challenging for someone with dementia to concentrate for that period of time. He experienced on several occasions that one could “fall into” the wall and when this occurred it was visually disorientating. In response to his feedback, we altered the design of virtual maze: (1) we applied a neutral wallpaper and a skirting board to the walls, (2) we shortened the length of the route, and (3) we narrowed the visual field to prevent getting too close to the walls. The finalised version of the virtual environment appears as if one were walking through a corridor or hallway in a building.

For the second stage, the researcher (AO) collected feedback on the interview questions and route learning task from four couples (patient and partner). After introducing the research study and the purpose of the interview (e.g., create nostalgic pictures), she trialled the interview questions with each couple. Each couple displayed distinct individual differences regarding the memories they viewed as nostalgic. After each meeting, most couples suggested either a new question or touched upon a new theme that the researcher (AO) built into the interview.

Next, the researcher (AO) presented the route learning task to each couple. Two out of the four individuals were unable to do the task. The two individuals unable to do the task had a diagnosis of early onset Alzheimer's disease and Lewy body dementia. The two gentlemen who successfully completed the task had a diagnosis of Mild Cognitive Impairment and moderate stage AD. This feedback gave an indication of the appropriate patient sample to be included in this study. The gentleman with MCI gave further advice on the number of trials he felt suitable for the task. He remarked that the task "made sense." The gentleman with moderate AD said how he found the task easy and became quickly comfortable with it, even though he had little previous experience with computers. After this final meeting, the researcher (AO) found there were no more improvements to be made on the task, and so we concluded the Patient and Public Involvement work.

C.2 Questionnaires Used In Experiment 4.1

Demographic Information

Please indicate your gender:

- Male
- Female
- Prefer not to say

Please type how old you are in years. _______

What age category do you belong to?

- 49 - 58 years old
- 59 - 68 years old
- 69 - 78 years old

People are often described as belonging to a particular racial group. Which of the following best describes you?

- Asian or Asian British
- Black/African/Caribbean/Black British
- Mixed ethnic groups
- White
- Other ethnic group, please state
- Do not wish to state

What is the highest level of education you have completed?

- Primary school
- GCSEs or equivalent

- A-Levels or equivalent
- University undergraduate programme
- University post-graduate programme
- Doctoral degree
- Other, please state

Adapted Southampton Nostalgia Scale

Nostalgia is a feeling that someone can have when they think about events that happened in the past.

Please read these stories about Joan and Ted, who feel nostalgia for something that happened when they were younger.

Joan enjoys thinking about the times she spent at the beach when she was younger. She looks at a colourful windmill that reminds her of this event. This memory is very important to Joan and she likes thinking about it and remembering what happened that day. Joan misses the event and wishes she could go back to that day. Joan feels happy but also a tiny bit sad as she thinks about it.

Ted finds his old football scarf and it makes him remember a time from when he was younger. As Ted looks at his scarf, it reminds him of special moments with his friends and the fun times they had together. He enjoys thinking about how good things were in the past and he wishes that he could travel back in time to experience those times again. Ted feels good about this memory.

Now, we would like to know if you feel nostalgia.

1. How much do you like to feel nostalgia?

1 2 3 4 5 6 7

Not at all Very much

2. How important is it for you to feel nostalgia?

1 2 3 4 5 6 7

Not at all Very much

3. How much do you enjoy the feeling of nostalgia?

1 2 3 4 5 6 7

Not at all Very much

4. How typical is it for you to have nostalgia when you think about the past?

1 2 3 4 5 6 7

Not at all Very much

5. How often do you feel nostalgia when you think about things that happened when you were younger?

1 2 3 4 5 6 7

Very rarely Very frequently

6. Generally speaking, how often do you feel nostalgia?

1 2 3 4 5 6 7

Very rarely Very frequently

7. Specifically, how often do you feel nostalgia? (Please check one.)

_____ At least once a day

_____ Three to four times a week

_____ Approximately twice a week

_____ Approximately once a week

_____ Once or twice a month

_____ Once every couple of months

_____ Once or twice a year

Brief Resilience Scale

Please read the following statements and rate your level of disagreement or agreement statement using the scale below.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I tend to bounce back quickly after hard times.	1	2	3	4	5
I have a hard time making it through stressful events.	1	2	3	4	5
It does not take me long to recover from a stressful event.	1	2	3	4	5
It is hard for me to snap back when something bad happens.	1	2	3	4	5
I usually come through difficult times with little trouble.	1	2	3	4	5
I tend to take a long time to get over set-backs in my life	1	2	3	4	5

Spatial Anxiety Scale

Please rate your level of anxiety when in the following situations. You should indicate your level of anxiety using the 1 to 5 scale below.

1	2	3	4	5
Not at all anxious				Very anxious

_____ Deciding which direction to walk in an unfamiliar city or town after coming out of a train/underground/bus station or multi-storey car park.

_____ Finding my way to an appointment in an unfamiliar area of a city or town.

_____ Leaving a store that I have been to for the first time and deciding which way to turn to get to a destination

_____ Finding my way back to a familiar area after realising I have made a wrong turn and become lost while traveling

_____ Finding my way in an unfamiliar shopping centre, hospital, or large building complex.

_____ Finding my way out of a complex arrangement of offices that I have visited for the first time.

_____ Trying a new route that I think will be a shortcut, without a map.

_____ Pointing in the direction of a place outside that someone wants to get to and has asked for directions, when I am in a windowless room.

Computer Experience

This questionnaire will ask you about how much experience you have had with computers.

Please rate the amount of experience you have had with using a computer.

1 = No experience at all, 7 = A lot of previous and recent experience.

1 2 3 4 5 6 7

How much experience do you have with playing computer games?

1 = No experience at all, 7 = A lot of previous and recent experience.

1 2 3 4 5 6 7

How much experience do you have with playing computer games which involve a virtual environment technology (e.g., flight stimulation)?

1 = No experience at all, 7 = A lot of previous and recent experience.

1 2 3 4 5 6 7

Nostalgia Familiarity

How familiar are you with the meaning of the word “nostalgia?” (select one option below)

_____ not at all

_____ somewhat

_____ reasonably well

_____ very well

Mild Cognitive Impairment Questionnaire

As a result of problems with memory or thinking, how often in the past four weeks have you experienced the following? Please select <u>one</u> response for each question.

	Never	Rarely	Some-times	Often	Always
1. Worry that you have forgotten things such as recent conversations or the names of things or people	☐	☐	☐	☐	☐
2. Worry that you have had problems constructing a sentence when talking	☐	☐	☐	☐	☐
3. Worry that you have forgotten what you had planned to do	☐	☐	☐	☐	☐
4. Worry that you have had problems remembering appointments or important dates, such as birthdays	☐	☐	☐	☐	☐
5. Worry about feeling generally 'slowed down'	☐	☐	☐	☐	☐
6. Worry that you have upset other people because of your memory problems	☐	☐	☐	☐	☐
7. Feeling you have become less independent because you have had to rely on your partner or other people to help you remember things	☐	☐	☐	☐	☐
8. Irritation or frustration about your memory problems	☐	☐	☐	☐	☐
9. Feeling worried about your memory problems	☐	☐	☐	☐	☐
10. Feeling downhearted or depressed about your memory problems	☐	☐	☐	☐	☐
11. Worry about other people's reactions to your memory problems	☐	☐	☐	☐	☐
12. Worry that your memory problems are more severe than those of other people of your age	☐	☐	☐	☐	☐

13. Worry about your memory getting worse in the future	☐	☐	☐	☐	☐

Nostalgia Manipulation Check

According to the Oxford Dictionary, 'nostalgia' is defined as a 'sentimental longing for the past.'

The following statements refer to how you feel right now. Please indicate your agreement or disagreement using the scale below.

1	2	3	4	5	6
Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree

___ Right now, I am feeling quite nostalgic.

___ Right now, I am having nostalgic feelings

___ I feel nostalgic at the moment.

Adapted Nostalgia Functions Scale

The following statements refer to the pictures you saw in the virtual environment (i.e., game 'Pathfinder). Please indicate your agreement or disagreement by using the scale below.

1	2	3	4	5	6
Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree

The pictures in the virtual environment…

___ made me feel loved

___ made me feel connected to loved ones

___ made me feel closer to my past

___ made me feel connected to who I was in the past

___ made me feel like life is meaningful

___ made me feel that life has a purpose

___ made me feel good about myself

___ made me feel valuable

___ made me feel happy

___ put me in a positive mood

___ made me feel sad

___ put me in a negative mood

C.3 Virtual Environment Instructions Used In Experiment 4.1

Please ensure that you are in a quiet and distraction-free space before starting the game. First, please make the programme full screen by clicking the blue box with two arrows in the bottom right-hand corner. For those who have corrected to normal vision, please make sure you are wearing your glasses or contact lenses before you start the game. Thank you!

In this game you will move through a virtual environment. It is possible that you could experience temporary motion sickness or nausea. If this happens, please stop the game immediately and withdraw from the study.

Welcome to the game, Pathfinder. The aim of this game is to find your way through an indoor virtual environment. To do this, you must follow the green arrows and they will guide you along a path. You will follow this path with the arrows three times.

Please do not write notes as you go through the environment, just try and follow the guided path. On your keyboard, use the "up" arrow to move forwards, the “down” to move backwards, the "left" arrow to turn left, and the "right" arrow key to turn right.

Pay attention to the pictures on the walls of the environment, as they will help you find your way along the path. You do not need to know the content of these pictures, they are simply there as a guide. Press F2 to continue. If the F2 key does not work, check to see if there is another key that has to be held down at the same time for the F2 key to work. For example, there may be 'Fn' key to press at the same time as the F2 key.

Please navigate the same path but without the green arrows this time. Press F2 to continue.

C.4 Picture Content Used In Experiment 4.1

Royal Family Events

1950s – Queen's Coronation, 1953

Sourced from: https://www.pinterest.co.uk/pin/497084877616029000/

1960s – Princess Margaret and Antony Jones's wedding, 1960

Sourced from: https://www.pinterest.co.kr/pin/456974693435938168/

1970s – Queen's Silver Jubilee, 1977

Sourced from: https://www.telegraph.co.uk/women/life/taking-to-the-streets-90-years-of-partying-with-the-queen/

Control – Prince William and Catherine Middleton's Wedding, 2011

Sourced from: https://www.pbs.org/newshour/world/watch-royal-wedding

Technology

1950s – Box Television Set

Sourced from: https://www.pinterest.co.uk/pin/242490761157873506/

1960s – Vinyl Record Player

Sourced from: https://thevinylfactory.com/features/rare-turntables-sale-ebay-july-2017/

1970s – Cassette Tape

Sourced from: https://sounds.bl.uk/Sound-recording-history/Equipment/029M-UNCAT11XXXXX-0001V0

Control – iPhone

Sourced from: https://www.businessinsider.com/how-do-i-get-my-iphone-out-of-headphone-mode?r=US&IR=T

Transport

1950s – Morris Minor

Sourced from: https://www.carandclassic.co.uk/car/C987491

<u>1960s</u> – Mini Cooper

Sourced from: https://en.wikipedia.org/wiki/Mini

<u>1970s</u> – Ford Cortina Mk3

Sourced from: https://www.pinterest.co.uk/pin/143552306851977672/

<u>Control</u> – Ford Fiesta

Sourced from: https://www.topgear.com/car-reviews/ford/fiesta/16-tdci-titanium-3dr/road-

Musicians

<u>1950s</u>

Doris Day

Sourced from: https://en.wikipedia.org/wiki/Doris_Day

Elvis Presley

Sourced from: https://www.newspapers.com/topics/famous-people/elvis-presley/

<u>1960s</u>

Beatles

Sourced from: https://movieposters.ha.com/itm/movie-posters/rock-and-roll/the-beatles-1960s-commercial-poster-42-x-58-rock-and-roll/a/161751-53036.s

Engelbert Humperdinck

Sourced from: https://www.amazon.co.uk/Release-Me-Engelbert-Humperdinck/dp/B01N1I256L

<u>1970s</u>

Queen

Sourced from: https://queenphotos.wordpress.com/2013/12/14/queen-1975-8/

ABBA

Sourced from: https://www.thecurrent.org/feature/2018/07/16/abba-a-swedish-perspective

Control

Adele

Sourced from: https://www.britannica.com/biography/Adele

Coldplay

Sourced from: https://www.imdb.com/name/nm1095892/mediaviewer/rm159059712

Comedians

1950s

Tommy Trinder

Sourced from: https://www.silversirens.co.uk/people/tommy-trinder/

Arthur Askey

Sourced from: https://jesseproject.weebly.com/lyrics.html

Control

Ricky Gervais

Sourced from: https://www.goldenglobes.com/articles/ricky-gervais-joking-about-death

Footballers

1950s - Stanley Mathews

Sourced from: https://www.blackpoolfcprints.com/archives/players/stanley-matthews-blackpool-1951-4204871.html

1960s - Bobby Charlton

Sourced from: https://notbottomline.wordpress.com/2014/11/20/importance-of-rooney-as-goalscorer-for-england-comparing-with-charlton-lineker/

1970s - Kevin Keegan

Sourced from: http://prints.colorsport.co.uk/football/kevin-keegan-hamburg-1978-5741095.html

Control - David Beckham

Sourced from: http://www.whoateallthepies.tv/wp-content/gallery/beckham-milan-genoa/

Olympic Athletes

1950s - Roger Bannister

Sourced from: https://achievement.org/achiever/sir-roger-bannister-2/

1960s – Smith & Carlos

Sourced from: https://www.history.com/news/1968-mexico-city-olympics-black-power-protest-backlash

1970s - Mary Peters

Sourced from: http://prints.colorsport.co.uk/athletics/1972-olympic-pentathlon-champion-mary-peters-5994263.html

Control - Mo Farah

Sourced from: https://www.lotterygoodcauses.org.uk/projects/view/mo-farah

Films

1950s

Alice in Wonderland, 1951

Sourced from: https://thatoldpictureshow.com/2018/08/16/revisiting-disney-alice-in-wonderland-1951/

Lady and the Tramp, 1955

Sourced from: https://www.britannica.com/topic/Lady-and-the-Tramp

Treasure Island, 1950

Sourced from: https://www.amazon.com/Treasure-Island-Classics-Fantastic-Adventure/dp/6304293941

1960s

Doctor Dolittle, 1967

Sourced from: https://www.pinterest.es/pin/87820261457556914/

Mary Poppins, 1964

Sourced from: https://gonewiththetwins.com/new/mary-poppins-1964/

101 Dalmatians, 1961

Sourced from: https://weheartit.com/entry/61391365

1970s

Aristocrats, 1970

Sourced from: https://vocal.media/geeks/the-aristocats-a-movie-review

Railway Children, 1970

Sourced from: https://www.imdb.com/title/tt0244750/mediaviewer/rm1603732992

Control

Alice in Wonderland, 2010

Sourced from: https://www.pinterest.at/pin/812688695232849860/

Frozen, 2019

Sourced from: https://www.denofgeek.com/movies/frozen-2-ending-explained/

Mary Poppins, 2018

Sourced from: http://www.talkingwithtami.com/im-flying-off-to-los-angeles-for-disney-mary-poppins-returns-premiere-more/

Doctor Dolittle, 2020

Sourced from: https://www.universalpictures.com/movies/dolittle

Star Trek Beyond, 2016

Sourced from: https://www.imdb.com/title/tt2660888/

TV shows

<u>1950s</u>

Flowerpot Men, 1952

Sourced from: https://bookmanpeedeel.wordpress.com/2015/09/03/drug-crazed-psychoticflowerpot-men/

Robin Hood, 1956

Sourced from: http://www.whirligig-tv.co.uk/tv/children/robinhood/robinhood.htm

Champion the Wonder Horse, 1955

Sourced from: https://nostalgiacentral.com/television/tv-by-decade/tv-shows-1950s/champion-wonder-horse/

<u>1960s</u>

Crackerjack

Sourced from: https://nostalgiacentral.com/television/tv-by-decade/tv-shows-1950s/crackerjack/

Thunderbirds, 1965

Sourced from: https://www.blu-ray.com/Thunderbirds/35264/

Star Trek, 1966

Sourced from: https://www.imdb.com/title/tt0060028/

First Doctor Who, 1963

Sourced from: https://en.wikipedia.org/wiki/First_Doctor

1970s

Wacky Races, 1968

Sourced from: https://www.abebooks.com/Wacky-Races-Annual-Hanna-Barbera-World/8451606195/bd

Clangers, 1969

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Dougal and the Magic Roundabout, 1970

Sourced from: https://www.amazon.co.uk/Dougal-Blue-Cat-Special-DVD/dp/B003VWDAOC

Scooby Doo, 1969

Sourced from: https://www.imdb.com/title/tt0063950/

Control

Thirteenth Doctor Who, 2020

Sourced from: https://www.mirror.co.uk/3am/celebrity-news/jodie-whittaker-confirms-future-doctor-21353797

C.5 Joystick Training Instructions Used In Experiment 4.2

‘Explore the Outdoors’

Page 1

Before we start, a gentle reminder to those who have corrected to normal vision. Please make sure you are wearing your glasses or contact lenses. Thank you!

It is possible that you could experience temporary motion sickness or nausea. If this happens, please inform the research team immediately.

Press the spacebar to continue

Page 2

Welcome to your joystick training session.

Virtual environments are often used in research. We understand this may be the first time you have come across this type of technology. So, we would like to start with a relaxed introduction.

The joystick beside you will help you move through the virtual environment. Find a comfortable place to hold onto the joystick. To move forward in the virtual environment you push the joystick in a forward motion or away from you. To turn left or right, simply move the joystick to your left or right hand side. To move backwards push the joystick in a backward motion or towards you.

Press the spacebar to continue

Page 3

In the first part of the training session we would like you to ‘Explore the outdoors.’ Get a feel for how to move the joystick whilst exploring an outdoor virtual environment.

Press the spacebar to start

‘Move Around the Maze’

Page 1

In the second part of the training session you will be placed the middle of a maze. Once there, your task will be to search around the maze. Learn how to turn in the maze using the joystick in a forward, backward, left or right motion.

Press the spacebar to start

‘Pathfinder’- Training Version

Page 1

In the third part of the session you will complete the training version of the game, Pathfinder. The aim of this game is to find your way through a building with pictures on the walls. To do this, you must follow the green arrows in the corridors. They will guide you along a path through the building.

To move, use the joystick in the same way as you did in the other games.

You will follow the path with the arrows 3 times. On the 4th trial we will take away the arrows, to see if you can find your way without them. Look at the pictures on the walls and learn the direction you have to go at each picture to help you find your way.

Page 2

Please navigate the same path but without the green arrows this time.

‘Pathfinder’

Page 1

First, a quick reminder for those who have corrected to normal vision, please make sure you are wearing your glasses or contact lenses before you start the game. Thank you!

In this game you will move through a virtual environment. It is possible that you could experience temporary motion sickness or nausea. If this happens, please inform the research team immediately.

Page 2

Welcome to the game, Pathfinder. The aim of this game is to find your way through a building. To do this, you must follow the green arrows and they will guide you along a path. You will follow this path with the arrows a few times.

When you are happy following the path we will take away the arrows to see if you can find your way without the arrows.

Look at the pictures on the walls and learn the direction you have to go at each picture to help you find your way.

The joystick beside you will help you move through the virtual environment. Move the joystick in exactly the same way as you were taught in the training session.

Page 3

Please navigate the same path but without the green arrows this time. Press the spacebar to continue.

C.6 Semi-Structured Interview Questions Used In Experiment 4.2

This interview will involve questions that trigger memories from your past. We will cover different themes which will include: transport, sports figures/heroes, technology, TV and film, musicians, places, fashion and, loved ones and important events. You do not have to answer to the questions, if you do not wish. It is up to you how much information you wish to disclose.

Generation/era

1. What generation or era, would you say you are part of?
2. What years/time frame were you growing up in your youth?
3. Is there a particular era or time-period in your life that you remember fondly?

Transport

4. When you were a child or young adult, how did you travel around?

Owned car, bicycle or motorcycle

5. Is there a *car/bicycle* that you particularly remember? Perhaps your first one?
6. What was the brand, make and colour of the *car/bicycle/motorcycle*?

Public transport (e.g. bus, train)

7. Do you fondly remember a particular *train/bus* you use to catch?
8. Where did you use to catch the *train/bus* from and to?
9. After reflecting on this, does it bring back any fond memories?

Sports figures/heroes

10. In the past, have you taken much interest in sports?

11. Have you ever been to a live sporting event? (e.g. Olympics, Wimbledon)
12. Are there any moments or achievements in sports history that particularly stand out to you?

Prompts: 1966 world cup, FA cup finals, famous players

13. Do you have a favourite sports figure/hero?
14. Growing up, was there a particular sporting icon you looked up to?

Technology

15. Did you use any technology when you were younger? Prompts, e.g., type writer, tape drives, disk drives, thin strip Tipp-ex, vinyl record player, TV, the brick phone, telephone boxes, dictor phones.
16. After discussing this, do you feel these memories bring back fond memories?

TV/Film

17. Have you ever had an interest in TV programmes and/or films?
18. How about TV adverts, did you have a favourite one when you were a child or young adult or did one particularly stand out to you?
19. Growing up, were there any particular TV programmes/movies you use to love watching?
20. What was the first TV you or your family owned? If yes, can you think of the make?

Musicians

21. Do you enjoy listening to music?

22. From what age, roughly, did you start actively listening to music?

23. What were your favourite musicians at that time? Perhaps you listened to at home, at a disco or dance class.

24. In your youth, were there any musicians that inspired you?

25. Did you have any posters up on your wall of your favourite bands or artists?

26. Did you ever go to a music concert or live gig?

27. If they are married, what was the artist to the first dance of your wedding?

Places

28. Where did you grow up and what was it like? (E.g. house, flat).

29. What town or city were you living in as a child or young adult?

30. Growing up, did you go on family holidays? If yes, do you have fond memories of particular holidays or destinations?

31. As a child or young adult, did you ever go on holidays? If yes, do you have fond memories of particular holidays or destinations?

32. In (said town/city), what did you use to do in your spare time?

33. Where did you use to hang out or go with friends or family?

34. Did you have a favourite place/spot?

Fashion

35. In your youth, what style of clothing did you use to wear? Prompts, e.g., flares

36. Can you remember the uniform you use to wear to work? What did it look it?

37. Did you have a favourite fashion style or fondly remember a particular fashion trend?

38. Did you use to go out in the evenings? If yes, what did you use to wear?

Women:

39. Did you use to wear dresses? If yes, did you have a favourite or signature style?
40. On your wedding day, what was the style of your wedding dress?

Loved ones and important events

41. Are there are special occasions or momentous life events you remember fondly?
42. Reflecting back, what memories do you feel represent a happy time in your life. This may be a trip away or a moment with a close loved one.

Thank you for your sharing with me the memories from your past. The final question is to reflect back on the interview and the memories you've shared with me today.

43. Out of the different themes we have journeyed through, what themes triggered the most vivid and fond memories from your past?

C.7 Tasks and Questionnaires Used In Experiment 4.2

Adapted Southampton Nostalgia Scale (completed by Study Partner)

Now, we would like to know if <u>your partner in the study</u> feels nostalgia.

1. How much does your partner like to feel nostalgia?

1	2	3	4	5	6	7
Not at all						Very much

2. How important is it for your partner to feel nostalgia?

1	2	3	4	5	6	7
Not at all						Very much

3. How much does your partner enjoy the feeling of nostalgia?

1	2	3	4	5	6	7
Not at all						Very much

4. How typical is it for your partner to have nostalgia when he or she thinks about the past?

1	2	3	4	5	6	7
Not at all						Very much

5. How often does your partner feel nostalgia when he or she thinks about things that happened when he or she was younger?

1	2	3	4	5	6	7
Very rarely						Very frequently

6. Generally speaking, how often does your partner feel nostalgia?

1	2	3	4	5	6	7
Very rarely						Very frequently

7. Specifically, how often does your partner feel nostalgia? (Please check one.)

_____ At least once a day
_____ Three to four times a week
_____ Approximately twice a week
_____ Approximately once a week
_____ Once or twice a month
_____ Once every couple of months
_____ Once or twice a year

Brief Resilience Scale (completed by Study Partner)

Please read the following statements. To the right of each you will find five numbers, ranging from "1" (Strongly Disagree) on the left to "5" (Strongly Agree) on the right. Circle the number which best indicates your partners feelings about that statement. For example, if you strongly disagree with a statement, circle "1". If you are neutral, circle "3", and if you strongly agree, circle "5", etc.

Please respond to each item by marking one box per row	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
He or she tends to bounce back quickly after hard times	1	2	3	4	5
He or she has a hard time making it through stressful events.	1	2	3	4	5
It does not take him or her long to recover from a stressful event	1	2	3	4	5
It is hard for him or her to snap back when something bad happens.	1	2	3	4	5
He or she usually comes through difficult times with little trouble.	1	2	3	4	5
He or she tends to take a long time to get over set-backs in his or her life	1	2	3	4	5

Spatial Anxiety Scale (completed by Study Partner)

Please rate what you think your partners level of anxiety would be when in the following situations presented below. You should indicate their level of anxiety by placing a number in the blank space preceding each situation. The number could be anywhere from 1 to 5, according to the following scale:

1	2	3	4	5
Not at all anxious				Very anxious

_____ Deciding which direction to walk in an unfamiliar city or town after coming out of a train/bus station or parking garage.

_____ Finding his or her way to an appointment in an unfamiliar area of a city or town.

_____ Leaving a store that he or she has been to for the first time and deciding which way to turn to get to a destination

_____ Finding his or her way back to a familiar area after realizing he or she has made a wrong turn and become lost while traveling.

_____ Finding his or her way in an unfamiliar shopping centre, hospital, or large building complex.

_____ Finding his or her way out of a complex arrangement of offices that he or she has visited for the first time.

_____ Trying a new route that he or she thinks will be a shortcut, without a map.

_____ Pointing in the direction of a place outside that someone wants to get to and has asked for directions, when he or she are in a windowless room.

Revised Nostalgia Manipulation Check

The following statements refer to how you felt in the game. Please indicate your agreement or disagreement using the scale below.

1	2	3	4	5	6
Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree

According to the Oxford Dictionary, 'nostalgia' is defined as a 'sentimental longing for the past.'

___ In the game, I felt quite nostalgic.

___ In the game, I had nostalgic feelings.

___ I felt nostalgic when I was playing the game.

Revised Nostalgia Functions Scale

The following statements refer to the pictures along the path in the game. Please indicate your agreement or disagreement by using the scale below.

1	2	3	4	5	6
Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Moderately agree	Strongly agree

The pictures ___ made me feel loved

The pictures ___ made me feel connected to loved ones

The pictures ___ made me feel connected with my past

The pictures ___ made me feel connected with who I was in the past

The pictures ___ made me feel like life in meaningful

The pictures ___ made me feel that life has a purpose

The pictures ___ made me feel good about myself

The pictures ___ made me feel valuable

The pictures ___ made me feel happy

The pictures ___ put me in a positive mood

The pictures ___ made me feel sad

The pictures ___ put me in a negative mood

Picture Recognition and Spatial Memory Task

Images Inserted Here

1. a. Did you see this picture during the game? Yes or no

b. In the game, which way did you have to go at this picture? Please tick one of the options below.

( ) Left

( ) Right

( ) Straight on

( ) Not sure

c. How confident do you feel about your answer to the previous question(s)? Please rate how confident you feel using the scale below.

1	2	3	4	5
Not confident at all				Very confident

C.8 Personalised Nostalgic Pictures Used In Experiment 4.2

Teddy Boys Era

LINE.17QQ.COM © 2010-2021

https://line.17qq.com/articles/qhggmsmqy_p3.html

Ford Consul

© Copyright 2021 Historics Auctioneers

https://www.historics.co.uk/buying/auctions/2015-03-07/cars/1961-ford-consul-375/

Old Savoy Ballroom, Southsea Pier

No copyright owner,

http://www.michaelcooper.org.uk/C/savoy1.htm

Southsea Parade Pier

© 2019 Hampshire History

https://www.hampshire-history.com/south-parade-pier-southsea-1928/

Ted Health

No copyright owner mentioned, sourced from:

https://en.wikipedia.org/wiki/File:Ted-Heath-Archive.jpg

Johnny Dankworth

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https://tidal.com/browse/album/16109828

Fairground, Hayling Island

No copyright owner mentioned, sourced from:

https://flashbak.com/british-amusement-park-and-fun-fair-postcards-from-the-1960s-403295/

Bridge Tavern Pub, Somers Road, Southsea

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https://portsmouthandsouthsea.co.uk/media/bridge-tavern-somers-rd.350/

Bantry Bay, Ireland

© Mystic View Design, Inc.

https://www.mystic-view.com/bantry-bay.php

Double Decker Bus

© Roger Cox

http://www.old-bus-photos.co.uk/?cat=184

Minivan

© Car From UK Team, «Car-from-UK.com» 2010 - 2021

https://car-from-uk.com/sale.php?id=20912&country=uk

Traverse City

© 2021 Martensprintworks - Vintage style poster art prints of Michigan and The Great Lakes

https://www.martensprintworks.com/product/traverse-city

Hampshire Cricket Club

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https://www.ebay.co.uk/itm/113865323870?mkevt=1&mkcid=1&mkrid=710-53481-19255-0&campid=5338722076&toolid=10001

Hop Inn Pub

No copyright owner mentioned, sourced from:

https://whatpub.com/pubs/HAS/00481/hop-inn-southampton

Old Wembley Stadium

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https://scottishschoolsfa.co.uk/well-be-coming/

Bobby Stokes, FA Cup Final

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https://www.mirror.co.uk/sport/football/news/lawrie-mcmenemy-says-history-can-9912218

Matt Le Tissier

No copyright owner mentioned, sourced from:

https://www.thefootballhistoryboys.com/2014/02/the-top-250-players-of-all-time-150-141.html

Commodore PET

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https://2warpstoneptune.com/2013/03/12/computer-lab-1980-the-commodore-pet/

Olympia Typewriter

© The Typewriter Database 2021

https://typewriterdatabase.com/1970-olympia-sm9.2474.typewriter

Lady in Red, Chris de Burgh

By Source, Fair use, https://en.wikipedia.org/w/index.php?curid=27832753

Bentley R Type

By Anton van Luijk - Flickr: Bentley R-Type, CC BY 2.0,

https://commons.wikimedia.org/w/index.php?curid=28574485

England Football Team, 1966

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https://www.fifa.com/worldcup/archive/england1966/

Hallam Cricket Club Logo

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https://hallam.play-cricket.com/

Freddy Truman

No copyright owner mentioned, sourced from:

https://www.dailymail.co.uk/sport/cricket/article-6161021/Sportsmail-experts-pick-Englands-greatest-cricketer.html#i-5eefb7459d78be21

Jeremy Leash

Photograph: S&G and Barratts/Empics

(modern)

https://www.theguardian.com/sport/2014/jun/08/johnny-leach

Jim Clark, Monaco, 1964

Sourced from © 2021 BBC. Photograph original: © 2021 Getty Images.

https://www.bbc.co.uk/news/uk-scotland-49495701

John Wayne

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https://www.rottentomatoes.com/m/1000560_alamo

The Rising Sun Pub

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http://www.sheffieldinsider.co.uk/sheffield-pubs-and-bars/nether-green/the-rising-sun/

Yacht by John Moody

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https://www.hanseyachtsag.com/moody/gb/moody/history/

Hamble Point, Moody Boat Yard

Original photograph: Francis Frith © Copyright Frith Content Inc 1998-2021

Sourced from: https://nelabligh.com/2011/09/12/103/

Strawberry Roan Pony

Sourced from: https://www.pikist.com/free-photo-iulqz

Horse Riding Shows in 1960s

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https://horseandcountry.tv/british-showjumping-celebrates-90-years/

Follyfoot Farm

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https://www.imdb.com/title/tt0163444/

White Horses

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https://nostalgiacentral.com/television/tv-by-decade/tv-shows-1960s/white-horses/

Elton John

Sourced from: https://powerpop.blog/2018/10/07/thoughts-on-elton-john-in-the-70s/

Judy Tzuke

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https://www.amazon.com/Stay-Till-Dawn-Judie-Tzuke/dp/B0000082WX

Double Decker Bus, Wigan

Photo RON HUNT, © 2021, wiganworld.co.uk

https://www.wiganworld.co.uk/album/photo.php?opt=3&id=24249&gallery=Wigan+Corporation+Transport&offset=140

Ferranti Computer

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http://www.computinghistory.org.uk/det/8093/Ferranti-Argus-PPC-20/

Singer Sewing Machine

Sourced from: https://oldsingersewingmachineblog.com/tag/singer-drawing-room-cabinet/

Hot Pants, 1970s

2021 © Glamour Daze

https://glamourdaze.com/2019/10/hot-pants-1971-memorable-1970s-fashion-trends.html

BOAC plane

© Photo credit: Richard Vandervord

https://www.britairliners.org/airliners-article?title=history-of-boac&id=24

Gramophone

Sourced from: https://www.pinterest.co.uk/pin/563583340843153180/

Singing in the Rain Film

© Metro-Goldwyn-Mayer Inc.

https://www.britannica.com/topic/Singin-in-the-Rain-film-1952

Elvis Presley

Metro-Goldwyn-Mayer, Inc.

http://www.doctormacro.com/Images/Presley,%20Elvis/Annex/Annex%20-%20Presley,%

20Elvis%20(Jailhouse%20Rock)_01.jpg

Lake Rukwa

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Hyena

Sourced from: https://www.westend61.de/en/imageView/MINF10464/a-spotted-hyena-crocuta-crocuta-stands-in-shallow-water-alert-bloody-face-river-bank-in-background

Livingstone Stanley Monument

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https://mapio.net/pic/p-26300474/

St Augustine Cathedral

Sourced from: http://thecasualobserver.co.za/port-elizabeth-yore-st-augustines-cathedral/

Austin

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https://www.wheels-alive.co.uk/austin-cambridge-a55-mark-iia60-morris-oxford-series-vvi-family-farina-models/

Cape Town

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https://www.hemmings.com/stories/2020/06/22/cape-town-south-africa-1970-2

Twenty, Raleigh Chopper

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http://velocitygirl.co.uk/2nd-bike-joy/#prettyPhoto

Beatles

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https://www.countrythangdaily.com/the-beatles-i-want-to-hold-your-hand/

Davy Jones, Monkees

Michael Ochs Archives/Getty Images

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https://www.biography.com/musician/davy-jones

Road to Morocco

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https://en.wikipedia.org/wiki/Road_to_Morocco#/media/File:Road_to_Morocco_(1942_poster).jpg

Blue Peter

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https://www.theguardian.com/tv-and-radio/2018/sep/24/blue-peter-digitises-every-episode-for-60th-anniversary

College Arms Pub

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Peter Pan Statue

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C.9 Additional Variables Recorded In Experiments 4.1 and 4.2

Experiment 4.1

Dependent Variables

Latency, navigational errors, feelings of being lost and anxious, spatial confidence, picture recognition, spatial memory.

Experiment 4.2

Medical Information

Medication use.

Dependent Variables

Latency, feelings of being lost and anxious.

C.10 Supplementary Moderation Analysis in Experiment 4.1

I ran a series of moderation models with nostalgia (nostalgia condition versus control condition) as the independent variable, the psychological functions of nostalgia as dependent variables, emotional and practical concerns as separate moderators, and spatial anxiety as a covariate. Neither practical (see Table C1) nor emotional concerns (see Table C2) moderated the effect of nostalgia on key psychological functions.

Table C1. Moderation Analyses with Practical Concerns as a Moderator

Dependent variable	*B*	*SE*	*t*	*p*	LLCI	ULCI
Manipulation check	0.01	0.02	0.58	.564	-0.030	0.054
Social connectedness	-0.02	0.02	-0.99	.324	-0.051	-0.017
Self-continuity	-0.03	0.02	-1.68	.095	-0.072	0.006
Meaning in life	-0.01	0.02	-0.38	.703	-0.044	0.029
Self-esteem	-0.01	0.02	-0.40	.698	-0.041	-0.028
Positive affect	-0.01	0.02	0.03	.978	-0.038	0.039

Note. LLCI = lower limit confidence interval; ULCI = upper limit confidence interval.

Table C2. Moderation Analyses with Emotional Concerns as a Moderator

Dependent variable	*B*	*SE*	*t*	*p*	LLCI	ULCI
Manipulation check	0.01	0.02	0.54	.589	-0.024	0.042
Social connectedness	-0.01	0.01	-0.65	.516	-0.036	0.018
Self-continuity	-0.03	0.02	-1.75	.083	-0.058	0.004
Meaning in life	-0.01	0.02	-0.01	.996	-0.019	0.019
Self-esteem	-0.01	0.01	-0.48	.631	-0.034	0.021
Positive affect	-0.01	0.02	-0.37	.710	-0.036	0.025

Note. LLCI = lower limit confidence interval; ULCI = upper limit confidence interval.

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