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Nostalgia assuages spatial anxiety☆

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ABSTRACT

According to the regulatory model of nostalgia, 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 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 (neutral condition). Consistent with the regulatory model, spatial anxiety (compared to the neutral condition) triggered nostalgia. In Experiments 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 2) or actively (computer-based task, Experiment 3) and then reported their spatial anxiety. Supporting the regulatory model, nostalgia (compared to control) reduced spatial anxiety (Experiments 2–3) and this, in turn, predicted higher goal setting (Experiment 3). Nostalgia assuages spatial anxiety during environmental navigation.

Nostalgia, a sentimental longing for one's past, has regulatory potential. We test this potential in the context of spatial anxiety. In three experiments, we examine whether spatial anxiety elicits nostalgia, and whether nostalgia decreases spatial anxiety and contributes to goal-setting in navigational tasks.

1. Nostalgia

Nostalgia is a prevalent emotion that is experienced throughout life (Hepper, Wildschut, Sedikides, Robertson, & Routledge, 2021; Juhl et al., 2020; Madoglou, Gkinopoulos, Xanthopoulos, & Kalamaras, 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, Ritchie, Sedikides, & Wildschut, 2012; Wildschut & Sedikides, 2022). This conceptualization of nostalgia generalizes across cultures (Hepper et al., 2014; Sedikides & Wildschut, 2022a).

Nostalgia has a distinct bittersweet or ambivalent affective signature, involving a blend of happiness and sadness (Frankenbach, Wildschut, Juhl, & Sedikides, 2021; Sedikides & Wildschut, 2016). Yet, the emotion is predominantly positive or, as Werman (1977, p. 393) put it, "a joy tinged with sadness." Leunissen, Wildschut, Sedikides, and Routledge (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 (see also Leunissen, 2023). Experience sampling studies corroborate this positivity offset for everyday nostalgia. For example, 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 ($M = 2.47$).

Nostalgia has also been charted by comparing it with other emotions. van Tilburg, Wildschut, and Sedikides (2018) instructed participants to rate 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

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most similar to pride, self-compassion, inspiration, and gratitude, and as most distinct from shame, hurt feelings, guilt, and embarrassment. van Tilburg, Bruder, Wildschut, Sedikides, and Göritz (2019) compared the appraisal profiles of 31 emotions. Nostalgia was the only one elicited by unique experiences that feel temporally or psychologically distant and are predominantly pleasant but irretrievable.

2. The regulatory model of nostalgia

According to the regulatory model of nostalgia, the emotion serves as a homeostatic corrective that counters the effects of adverse psychological and environmental conditions (Wildschut & Sedikides, 2023a, 2023b). 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, Sedikides, Arndt, and Routledge (2006) examined nostalgia's regulatory role in relation to the negative psychological state of loneliness (see also: Abeyta & Juhl, 2023; Zhou et al., 2022; Zhou, Sedikides, Wildschut, & Gao, 2008). They demonstrated that high (compared to low) loneliness, successfully induced via false feedback, triggered nostalgia (Study 4). In turn, nostalgia, elicited 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, Sedikides, and Wildschut (2018) tested the regulatory model in relation to negative environmental conditions, specifically adverse weather (see also Zhou, Wildschut, Sedikides, Chen, & Vingerhoets, 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, including social connectedness, meaning in life, self-continuity, self-esteem, positive affect, and optimism (Study 4).

3. Spatial anxiety and nostalgia

The key objective of the current research was to test the regulatory model in relation to spatial anxiety, that is, apprehension about environmental navigation (Lyons et al., 2018; Malanchini et al., 2017). Navigation is an essential multisensory skill (Golledge, 1999; Gramann, Müller, Schönebeck, & Debus, 2006). Successful navigation allows one to reach desired places, source food, socialize, and explore as well as achieve well-being and equanimity. By contrast, losing one's bearings can be unsettling and confusing (Carlson, Hölscher, Shipley, & Dalton, 2010; Lynch, 1960). Spatial anxiety undermines one's confidence in their navigational ability, resulting in impaired navigation performance (Hund & Minarik, 2006; Walkowiak, Foulsham, & Eardley, 2015).

We evaluated the regulatory model in two steps, implementing an experiment-causal-chain strategy (Spencer, Zanna, & Fong, 2005). First, we tested the impact of spatial anxiety on nostalgia. We propose that spatial anxiety is a potent nostalgia trigger because it entails an unsettling sense of being lost in unfamiliar surroundings (Oliver, Wildschut, Parker, Wood, & Redhead, 2023). Such discomforting disorientation will strengthen the need for familiarity and reassurance, rendering one disposed and receptive to heartening nostalgic memories of well-known persons, places, and activities from the past. In Experiment 1, we induced spatial anxiety by training participants to navigate a route in a virtual maze and then surreptitiously (i.e., without informing them) changing part of the previously learned route (spatial-anxiety condition) or leaving the route unchanged (neutral condition). Prior research has validated this spatial-anxiety induction (Oliver et al., 2023). We hypothesized that spatial anxiety (compared to the neutral condition) would trigger nostalgia (H1).

Second, we tested the effect of nostalgia on spatial anxiety. We propose that nostalgia is well-suited to assuage spatial anxiety, because it is a predominantly positive and calming (i.e., low arousal; van Tilburg, 2023; van Tilburg, Wildschut, & Sedikides, 2018) emotion that entails a sense of familiarity, comfort, and safety (Fleury, Sedikides, Wildschut, Coon, & Komnenich, 2022); indeed, the Greek word *nostos*, from which nostalgia derives, refers to homecoming. In Experiments 2–3, we displayed nostalgic (nostalgia condition) or matched control (control condition) pictures in a virtual maze. Previous research has established the potential of these pictures to elicit nostalgia (Redhead et al., 2023). Participants navigated the maze passively (video clip, Experiment 2) or actively (computer-based task, Experiment 3). We hypothesized that nostalgia (compared to control) would reduce spatial anxiety (H2).

Our third hypothesis pertains to the beneficial downstream consequences of nostalgia-induced reductions in spatial anxiety for goal setting. Nostalgia strengthens approach motivation and goal pursuit (Abeyta, Routledge, & Juhl, 2015; Sedikides et al., 2018; Sedikides & Wildschut, 2020, 2022b; Stephan et al., 2014). Building on this evidence, we propose that, by virtue of its capacity to reduce spatial anxiety, nostalgia will increase goal setting in the navigational domain (H3). This mediational hypothesis flows from the expectancy-value perspective on goal setting (Campbell, 1982; Levy & Baumgardner, 1991; Lewin, Dembo, Festinger, & Sears, 1944), which maintains that goal choice is a function of one's perceived ability to achieve the goal and the value one assigns to the goal. Accordingly, if nostalgia soothes spatial anxiety, this will increase one's perceived ability to complete a challenging navigation task and thus result in higher goal setting in the navigational domain. We tested this hypothesis in Experiment 3.

We received ethical approval from the first author's institution. Consent forms stated that participants should have normal or corrected-to-normal vision. Across experiments, participants were predominantly White British residents of the United Kingdom. We report all measures, manipulations, and participant exclusions for all studies, 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/?view_only=7bf7ff8a404c499bbbc0ca02247bbf1a).

4. Experiment 1

In Experiment 1, we tested the impact of spatial anxiety on nostalgia. We used a validated task to manipulate spatial anxiety in the context of a virtual maze (Oliver et al., 2023). Virtual environments have been used extensively as an effective methodological tool to simulate real-world settings, thus strengthening external validity (Grzeschik et al., 2021; Hilton, Johnson, Slattery, Miellet, & Wiener, 2021; Lingwood, Blades, Farran, Courbois, & Matthews, 2015; O'Malley, Innes, & Wiener, 2018; Ruddle, Payne, & Jones, 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, Montello, & Hegarty, 1999). We first trained participants to navigate a route within the maze and then surreptitiously (i.e., without informing them) changed part of the previously learned route (spatial-anxiety condition) or left the route unchanged (neutral condition). We hypothesized that participants in the spatial-anxiety condition would feel more nostalgic than those in the neutral condition (H1).

4.1. Method

4.1.1. Participants and design

Sixty-four University of Southampton undergraduate students (39 women, 25 men) took part in a 40-min 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 neutral ($n = 32$) 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 $\alpha = 0.05$ (G*Power 3.1; Faul, Erdfelder, Lang, & Buchner, 2007). We met this recruitment target.

4.1.2. 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 1.3 m wide desk in the center of the rear wall. Three identical 15-in. LCD monitors were arranged so that images were shown continuously across all three screens. We developed three computer-generated mazes 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 otherwise 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. Fig. 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., 2023). 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 (Supplementary Material, Fig. S1). 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 (Supplementary Material, Fig. S2). The three training trials were followed by a test trial, in which we removed the arrows and participants retraced the path they had learned in the training phase. In the neutral 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 (Supplementary Material, Fig. S3). After the fifth turning point, this new maze displayed 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 min, the experimenter guided them to the end destination.

4.1.3. Dependent variables

Immediately after the second route-learning task, we assessed the following dependent variables.[1]

[1] For exploratory purposes, we assessed a number of additional variables (Supplementary Material) but only analyzed and report the measures that test our key hypothesis.

Manipulation Checks. We administered two manipulation checks to assess participants' momentary spatial anxiety. The first scale, which we constructed for the purposes of this experiment, comprised three face-valid items ("Right now, I feel a bit lost," "… I have the sense of being lost," "… I feel disoriented"; 1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = 0.94$, $M = 2.86$, $SD = 1.46$). 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 (1 = *not at all anxious*, 5 = *very anxious*; $\alpha = 0.87$, $M = 2.80$, $SD = 0.86$). The Spatial Anxiety Scale assesses aspects of large-scale spatial anxiety rather than just feeling lost and disoriented. The scale has been used extensively in the spatial navigation literature (Davis & Veltkamp, 2020). The two manipulation checks were moderately and positively correlated, $r(64) = 0.43$, $p < .001$ (for scatter plot, see Supplementary Material, Fig. S9).

Nostalgia. We assessed momentary nostalgia with two scales. First, we administered a state version of the Nostalgia Inventory (Batcho, 1995). Participants rated how much they missed 18 persons, situations, or events from their past (e.g., "Family," "Places," "Holidays")[2] in the present moment (1 = *I do not miss at all*, 6 = *I miss very much*; $\alpha = 0.86$, $M = 2.99$, $SD = 0.83$). Next, we administered a validated 3-item measure of state nostalgia (Hepper et al., 2012; Wildschut, Sedikides, Routledge, & Arndt, 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*; $\alpha = 0.95$, $M = 3.13$, $SD = 1.46$). The two nostalgia measures were highly and positively correlated, $r(64) = 0.65$, $p < .001$ (for scatter plot, see Supplementary Material, Fig. S10).

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 (1 = *strongly disagree*, 6 = *strongly agree*). We averaged the respective items to create positive affect ($\alpha = 0.95$, $M = 4.25$, $SD = 0.99$) and negative affect ($\alpha = 0.94$, $M = 2.15$, $SD = 1.09$) indices.

4.2. Results and discussion

We display distributions of key outcome variables in Fig. 2. For positive affect and negative affect, we display distributions in Supplementary Material, Fig. S11.

4.2.1. 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 neutral 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 neutral condition ($M = 2.54$, $SD = 0.71$), $F(1, 62) = 6.17$, $p = .016$, $f = 0.28$. The spatial-anxiety manipulation was effective.

4.2.2. Nostalgia

Participants in the spatial-anxiety condition ($M = 3.20$, $SD = 0.67$)

[2] 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 the current cultural context. In line with this prior research, we made the a priori decision to exclude the two items from present use.

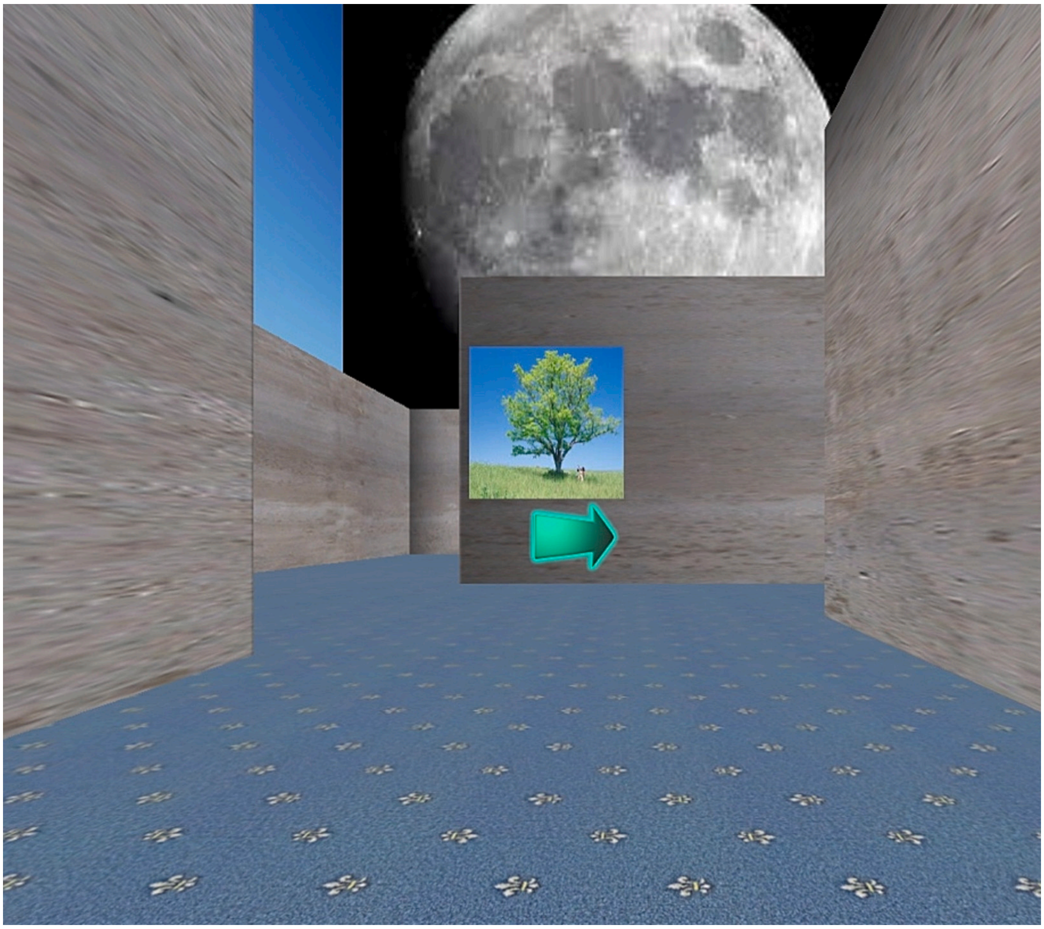

Fig. 1. Virtual maze presentation from a participant's perspective.

felt significantly more nostalgic for persons, situations, or events from their past (as assessed by the Nostalgia Inventory) than those in the neutral 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 neutral condition ($M = 2.64$, $SD = 1.48$), $F(1, 62) = 8.25$, $p = .006$, $f = 0.34$.

The spatial-anxiety and neutral conditions did not differ significantly on positive affect ($M_{\text{spatial anxiety}} = 4.17$, $SD = 0.99$ vs. $M_{\text{neutral}} = 4.33$, $SD = 1.00$; $F[1, 62] = 0.40$, $p = .531$, $f = 0.00$) or negative affect ($M_{\text{spatial anxiety}} = 2.19$, $SD = 1.11$ vs. $M_{\text{neutral}} = 2.11$, $SD = 1.09$; $F[1, 62] = 0.08$, $p = .777$, $f = 0.00$). The effect of spatial anxiety on nostalgia remained significant when controlling simultaneously for PA and NA: for the Nostalgia Inventory, $F(1, 61) = 4.46$, $p = .039$, $f = 0.23$; 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 (vs. neutral condition) augmented nostalgia, supporting H1. This finding is consistent with the regulatory model of nostalgia, according to which aversive states trigger nostalgia. The regulatory model further posits that nostalgia, in turn, counteracts these aversive states. Applying this proposition to our research, nostalgia would reduce spatial anxiety (H2). We tested this hypothesis next by directly manipulating nostalgia within a virtual maze.

5. Experiment 2

In Experiment 2, we examined the influence of nostalgia on spatial anxiety. Participants watched a video recording from a first-person perspective, moving through a virtual maze. Chrastil and Warren (2011) tested route learning, and found no difference between a passive navigation task (as in the current experiment) and an active navigation task (as in Experiments 1 and 3). 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).

5.1. Method

5.1.1. Participants and design

Two hundred and thirty-one visitors (196 women, 40 men) attended a series of six open days at 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 ($n = 19$).[3] Participants completed the 30–min 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 1 examined a new independent variable (spatial anxiety), we could turn to a prior

[3] Institutional requirements prohibited the recording of individual ages and the linking of demographic information with individual participant responses.

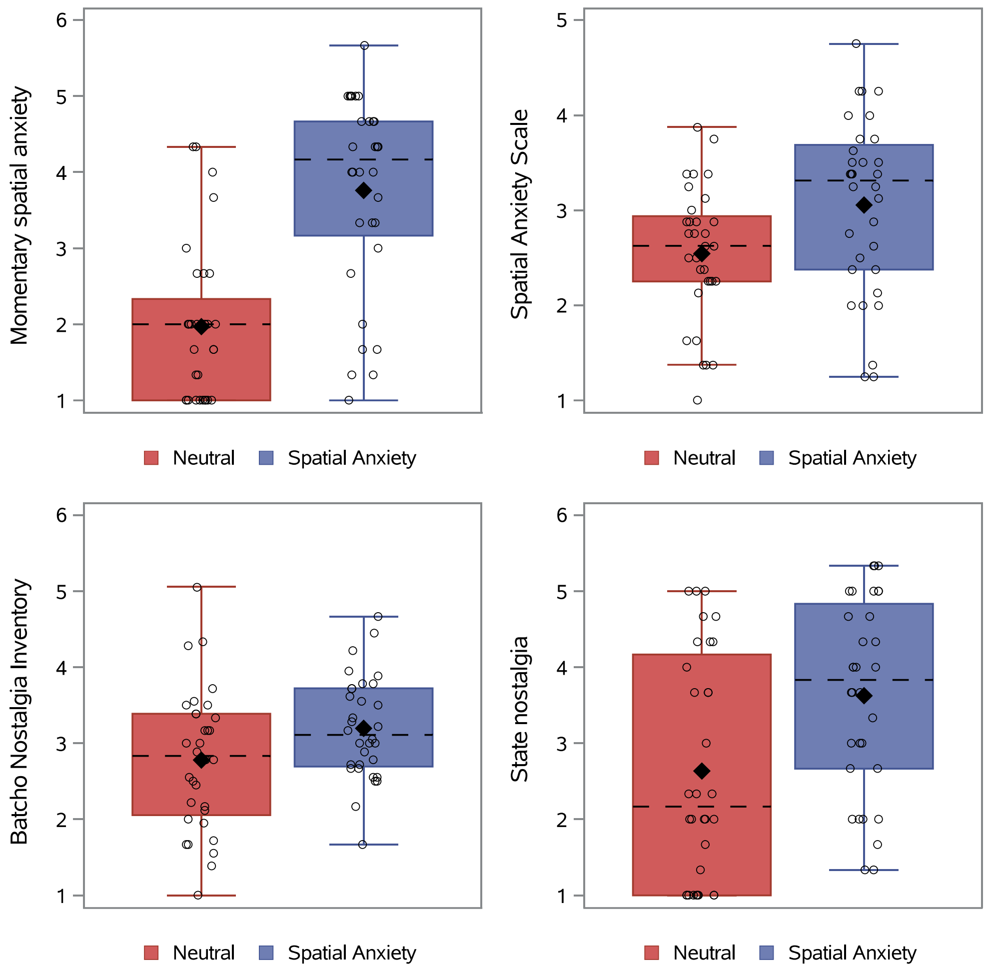

Fig. 2. Box and scatter plots of key outcome variables as a function of spatial anxiety in Experiment 1.
Note. The box plots display mean (diamond), median (dashed line), and interquartile range. Whiskers indicate the maximum (minimum) values below (above) the upper (lower) fence. The overlaid jittered scatter plots display individual participant responses.

study that implemented the same dependent variables (measures of nostalgia) to inform our effect size estimate. At the time of the current experiment (and Experiment 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 afford at least 80% power to detect a medium-sized effect ($f = 0.25$; $\alpha = 0.05$). 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).

5.1.2. Procedure and materials

Participants completed two route-learning tasks involving exploration of a virtual maze. The first task contributed a baseline measure of spatial memory and the second provided the context for the experimental manipulation of nostalgia.

Route-Learning Tasks. The first route-learning task served to acquaint participants with a virtual maze (Supplementary Material, Fig. S4). 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 s and a series of directional arrows guided the viewer along a specified route. The walls of the maze displayed eight colorful pictures with neutral content (e.g., apple; Fig. 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 also 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 (Supplementary Material, Fig. S5). The video recording lasted approximately 60 s. 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, Bonus, & Wing, 2020). In the control condition, the corresponding image depicted Emma Watson at the time of the experiment (Fig. 3). In prior research (Redhead et al., 2023), the pictures in the nostalgia condition elicited greater nostalgia than those in the control condition.

5.1.3. Dependent variables

After watching the second clip, participants completed the

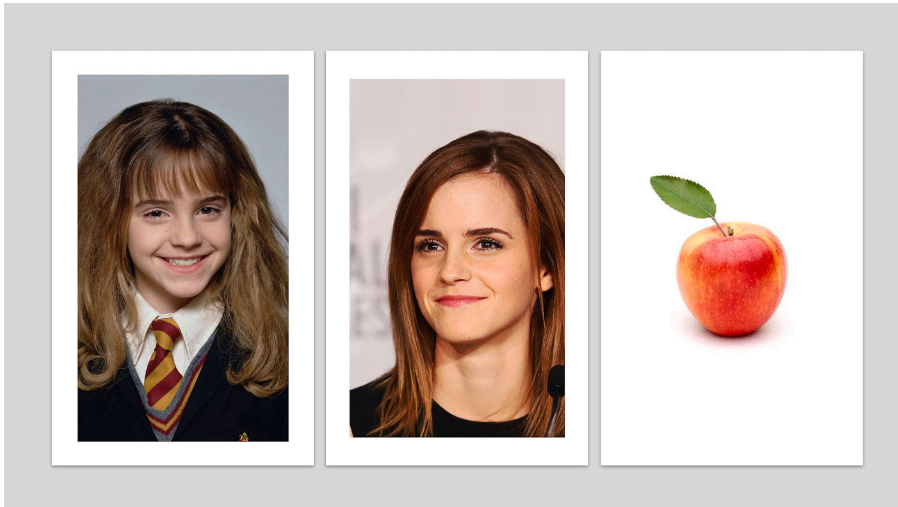

Fig. 3. Examples of nostalgic, matched non-nostalgic, and neutral pictures.

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 maze"; $M = 3.30$, $SD = 1.62$). Response options ranged from 1 (*strongly disagree*) to 6 (*strongly agree*).

5.2. Results and discussion

We display distributions of responses in Fig. 4. 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, nostalgic participants ($M = 3.01$, $SD = 1.53$) experienced less spatial anxiety than control participants ($M = 3.56$, $SD = 1.65$), $F(1, 229) = 6.87$, $p = .009$, $f = 0.17$. Nostalgia reduced spatial anxiety, supporting H2.

We successfully implemented a 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 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 reducing spatial anxiety, promote higher goal setting in the navigational domain? We addressed these issues in Experiment 3. We manipulated nostalgia in an active navigation task, assessed outcome variables with multi-item measures, and examined goal setting as a downstream consequence of reduced spatial anxiety.

6. Experiment 3

In Experiment 3, we examined the impact of nostalgia on spatial anxiety in an active navigation task. We used the same pictorial nostalgia manipulation as in Experiment 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. According to the expectancy-value perspective on goal setting (Campbell, 1982; Levy & Baumgardner, 1991; Lewin et al., 1944), goal choice is a function of one's perceived ability to achieve the goal and the value one assigns to the goal. If nostalgia soothes spatial anxiety, it should increase one's perceived ability to complete a challenging navigation

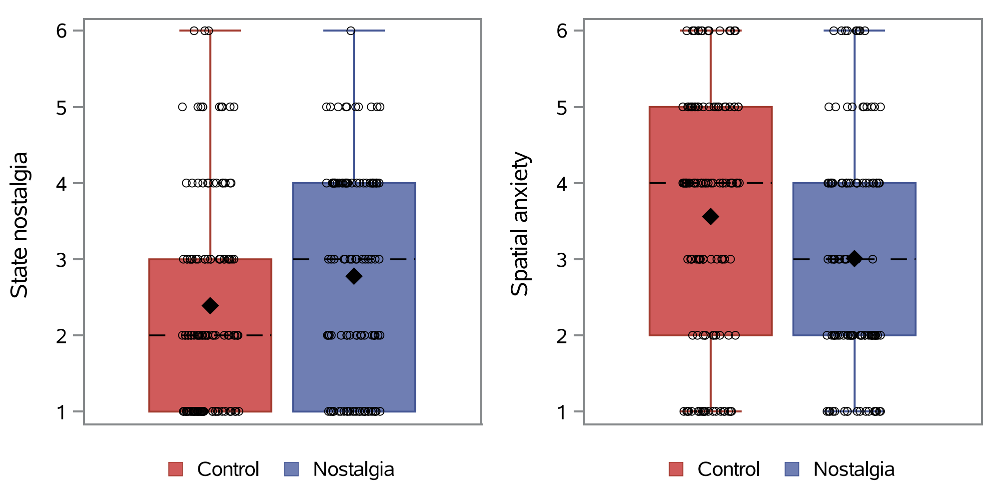

Fig. 4. Box and scatter plots of outcome variables as a function of nostalgia in Experiment 2.
Note. The box plots display mean (diamond), median (dashed line), and interquartile range. Whiskers indicate the maximum (minimum) values below (above) the upper (lower) fence. The overlaid jittered scatter plots display individual participant responses.

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. Participants completed either an easy maze with three decision points or a difficult maze with 11 decision points. Some prior research has suggested that beneficial effects of nostalgia can be pronounced under challenging circumstances (Sedikides et al., 2015; van Dijke, Leunissen, Wildschut, & Sedikides, 2019). Accordingly, we explored if nostalgia would reduce spatial anxiety more in a difficult (than easy) maze.

6.1. Method

6.1.1. 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-min 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 2 ($f = 0.25$). The power analysis yielded a sample size requirement of 128 to achieve 80% power ($\alpha = 0.05$). We fell slightly short of this target and achieved a sample size of 120. A sensitivity power analysis revealed that this sample size 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 $ns = 30$).

6.1.2. Procedure and materials

We used the same equipment as in Experiment 1. Participants were tested in closed cubicles, free from distractions. 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.

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 (Supplementary Material, Fig. S6). 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 three 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 (Supplementary Material, Fig. S7). The difficult maze contained neutral pictures at each of 11 decision-making points, and nostalgic/matched control pictures at two 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 (Supplementary Material, Fig. S8).

6.1.3. Dependent variables

After the second route-learning task, we assessed the following dependent variables.[4]

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*; $\alpha = 0.92$, $M = 2.97$, $SD = 1.26$).

Spatial Anxiety. Participants rated how spatially anxious they felt during the navigation task on two scales. The first was a face-valid scale that we constructed for the purpose of this experiment. It contains four items: "During the navigation task, I felt lost," "… disoriented," "… adrift," and "… like going around in circles" (1 = *strongly disagree*, 6 = *strongly agree;* $\alpha = 0.90$, $M = 2.44$, $SD = 1.24$). We labelled this the Disorientation Scale, after the highest-loading item.[5] The second was the Spatial Anxiety Scale of Experiment 1 (1 = *not at all anxious*, 5 = *very anxious*; $\alpha = 0.86$, $M = 2.83$, $SD = 0.82$). The two measures were moderately and positively correlated, $r(119) = 0.35$, $p < .001$ (for scatter plot, see Supplementary Material, Fig. S12).

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 ($M = 0.63$, $SD = 0.04$).

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 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 (i.e., recall for neutral pictures did not differ significantly between conditions). This free recall test was the same as in Redhead et al. (2023).

6.2. Results

Unless otherwise specified, we entered the dependent variables in a 2

Table 1
Means (standard deviations) as a function of nostalgia and maze difficulty in Experiment 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)
Disorientation Scale	2.49 (1.16)	2.83 (1.26)	2.16 (1.33)	2.27 (1.15)
Spatial Anxiety Scale	2.73 (0.69)	3.28 (0.94)	2.65 (0.70)	2.66 (0.78)
Goal setting	0.63 (0.09)	0.43 (0.09)	0.77 (0.08)	0.69 (0.09)
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.

[4] We measured additional variables for exploratory purposes (Supplementary Material). We only analyzed and report the measures that test our hypotheses.

[5] We examined the factorial validity of this new scale by using confirmatory factor analysis to fit a 1-factor model. The model fit was excellent, $\chi^2(2) = 0.19$, $p = .910$, SRMR = 0.004, CFI = 1.00. All standardized factor loadings >0.78.

(nostalgia vs. control) × 2 (difficult maze vs. easy maze) Analysis of Variance. We present means and standard deviations in Table 1 and display distributions of responses in Fig. 5. Degrees of freedom vary due to missing values.

6.2.1. Manipulation check

Analysis of the manipulation check (i.e., felt nostalgia) revealed a significant main effect of nostalgia, $F(1, 116) = 8.91$, $p = .003$, $f = 0.26$. 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.

6.2.2. Spatial anxiety

For the Disorientation Scale, results revealed a significant nostalgia main effect, $F(1, 116) = 3.94$, $p = .049$, $f = 0.16$. Supporting H2 and conceptually replicating Experiment 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, $F(1, 116) = 0.25$, $p = .617$, $f = 0.00$, was significant.[6]

Analysis of the Spatial Anxiety Scale also revealed a significant nostalgia main effect, $F(1, 115) = 5.96$, $p = .016$, $f = 0.21$. 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 trending, indicating that participants tended to report more spatial anxiety after navigating the difficult (than easy) maze, $F(1, 115) = 3.84$, $p = .053$, $f = 0.16$. The interaction effect was also trending, $F(1, 115) = 3.47$, $p = .065$, $f = 0.15$, indicating that the effect of nostalgia (vs. control) on spatial anxiety was numerically (but not significantly) larger in the difficult than easy maze.

6.2.3. 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 higher in the nostalgia condition (43:59 = 0.73) than in the control condition (32:60 = 0.53), $\chi^2(1, N = 119) = 4.66$, $p = .031$, $b^* = 0.24$. The effect of maze difficulty was not significant, $\chi^2(1, N = 119) = 2.32$, $p = .128$, $b^* = -0.17$, nor was the interaction effect, $\chi^2(1, N = 119) = 0.29$, $p = .592$, $b^* = 0.06$.

6.2.4. 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 the PROCESS macro (Hayes, 2022). The analysis with the Disorientation Scale 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, $ab = 0.17$, $SE = 0.09$, 95% CI = [0.025, 0.392]. Reduced spatial anxiety mediated the effect of nostalgia on higher goal setting in the navigation domain.

6.2.5. Picture recall

Finally, we examined the number of nostalgic/matched control pictures that participants recalled, out of a total of 10. Given that the difficult and easy maze included the same number of nostalgic/matched control pictures, we did not expect a significant main effect of maze difficulty, and there was none, $F(1, 115) = 0.86$, $p = .357$, $f = 0.08$. Further, neither the main effect of nostalgia, $F(1, 115) = 0.24$, $p = .626$, $f = 0.04$, nor the interaction effect, $F(1, 115) = 0.36$, $p = .551$, $f = 0.05$, was significant. These findings replicate those of Redhead et al. (2023) using the same stimuli. Thus, there was no indication that the nostalgic pictures were more recognizable or memorable than the matched control ones.

6.3. 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 (both measures). 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, Shaw, Saari, & Latham, 1981), raising the prospect of further beneficial downstream consequences of nostalgia in a navigational context.

We acknowledge that the mediator, spatial anxiety, was measured rather than manipulated and, hence, the mediation analyses did not establish causality (Fiedler, Harris, & Schott, 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, Schott, & Meiser, 2011). The results did not support a moderating role of maze difficulty. An explanation is that the maze-difficulty manipulation lacked strength. The main effect of maze difficulty on the spatial anxiety measures (which could be regarded as checks on the maze-difficulty manipulation) was numerically small and not statistically significant. Future research could address this issue by implementing a stronger maze-difficulty manipulation.

7. General discussion

Spatial anxiety entails disorientation and confusion, and erodes one's navigational confidence and performance (Hund & Minarik, 2006; Lynch, 1960; 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, 2023a, 2023b). 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 1, a validated spatial-anxiety induction (Oliver et al., 2023) increased nostalgia, supporting H1. Second, a novel, pictorial nostalgia induction (Redhead et al., 2023) reduced spatial anxiety in passive (Experiment 2) and active (Experiment 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).

7.1. Implications

Our findings have theoretical, methodological, and applied

[6] Inspection of the distribution of Disorientation Scale scores (Fig. 5) revealed four high outliers in the nostalgia condition. A Komolgorov-Smirnov test showed that the distribution function did not differ significantly between the nostalgia and control conditions, $D = 0.23$, $p = .076$. As a robustness check, we tested the difference between the nostalgia and control conditions using the non-parametric Wilcoxon rank-sum test, which corroborated the significant effect of nostalgia (vs. control) on reduced spatial anxiety, $Z = -2.34$, $p = .020$.

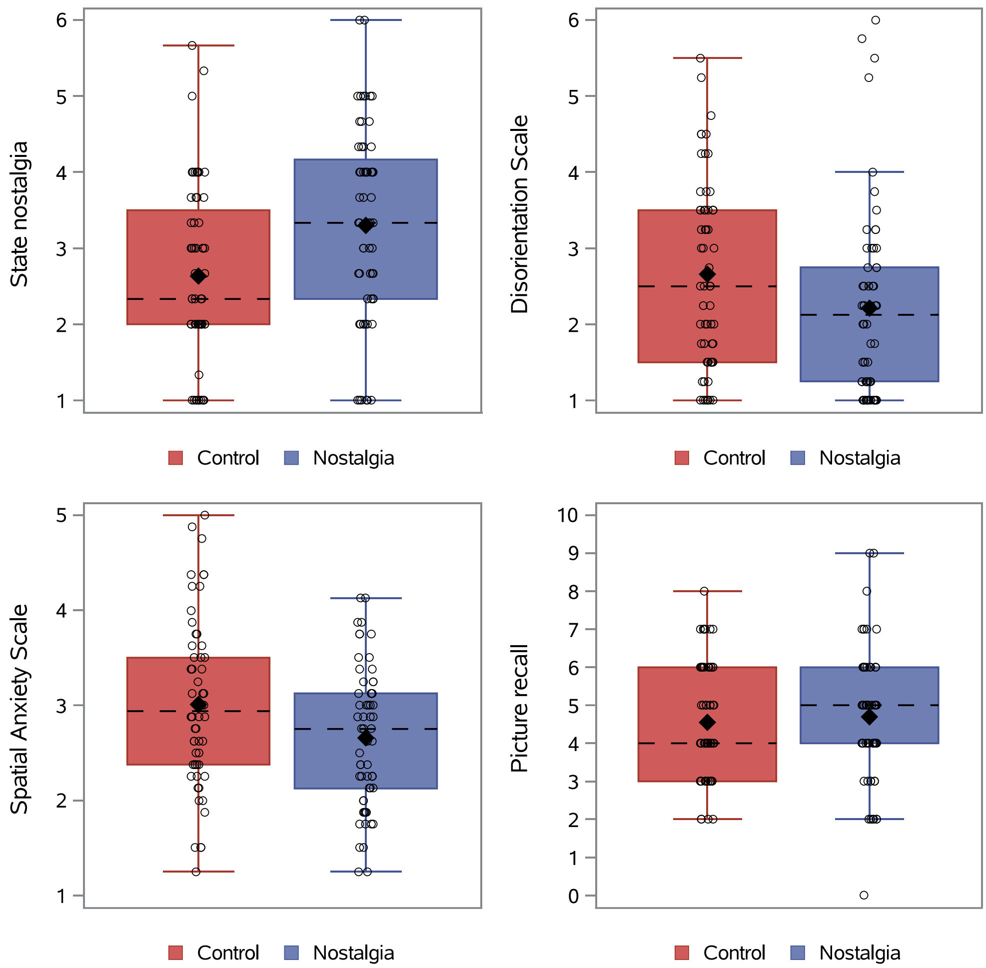

Fig. 5. Box and scatter plots of outcome variables as a function of nostalgia in Experiment 3.
Note. The box plots display mean (diamond), median (dashed line), and interquartile range. Whiskers indicate the maximum (minimum) values below (above) the upper (lower) fence. The overlaid jittered scatter plots display individual participant responses.

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, Igou, & van Tilburg, 2021) and loneliness (by increasing 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, Sedikides, & Wildschut, 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, such as impaired vision or hearing.

As for our methodological contribution, we successfully implemented a recently developed pictorial nostalgia induction (Redhead et al., 2023). The Event Reflection Task (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). Yet, methodological diversity is a prerequisite for valid causal inferences and, indeed, researchers have developed a variety of nostalgia inductions to meet this objective (Wildschut & Sedikides, 2023), including ones based on music or song lyrics (Sedikides, Leunissen, & Wildschut, 2022), photographs (Yang et al., 2021), scents (Reid, Green, Wildschut, & Sedikides, 2015), tastes (Reid et al., 2023), and prototype features (Cheung, Sedikides, & Wildschut, 2017). Our pictorial 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 independent functioning and social interaction. Losing this ability can have serious consequences, as seen in individuals with neurological conditions, such as Alzheimer's disease, epilepsy, stroke, and topographical disorientation disorders (Barrett & Muzaffar, 2014; Cimadevilla, Lizana, Roldán, Cánovas, & Rodríguez, 2014; Iaria & Barton, 2010; Monacelli, Cushman, Kavcic, & Duffy, 2003). People living with dementia, for example, are more likely to become spatially disoriented, lost, and anxious during their regular day-to-day activities (Chiu et al., 2004; Davis & Veltkamp, 2020)—a distressing experience that can further reduce confidence in exploring environments and thus limit autonomy. It is, then, important to consider how to support individuals and groups who experience wayfinding difficulties. Environmental design guidelines recommend using signage, landmarks, and artwork to reduce spatial anxiety and facilitate wayfinding (O'Malley, Innes, & Wiener, 2017). Landmarks that are distinct, memorable, and salient are particularly effective navigational aids (Caduff & Timpf, 2008). Our findings indicate that incorporating nostalgic design elements, such as wall mounted pictures, within the physical environment can further this goal.

7.2. Limitations and future directions

Although we successfully induced spatial anxiety in Experiment 1, we cannot rule out that the spatial-anxiety manipulation also heightened general anxiety, which is characterized by negative affect, fearfulness, and worry. Different types of domain-specific anxiety (e.g., mathematical, test, spatial) and general anxiety are distinct and only modestly correlated (Alvarez-Vargas, Abad, & Pruden, 2020; McKheen, 2011). Furthermore, the small overlap that does exist is primarily due to shared genetic factors rather than to shared environmental factors (Malanchini et al., 2017), suggesting that the spatial-anxiety manipulation—an environmental factor—is unlikely to have simultaneously induced general anxiety. The null effect of the spatial-anxiety manipulation on negative affect supports this argument. 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.

The pictures we used in Experiments 2–3 focused on a particular theme (i.e., popular movies, popular music artists) that we expected to elicit nostalgia in our predominantly young-adult samples; that is, we adopted a nomothetic approach to manipulating the emotion (i.e., establishing general principles that apply to a particular cohort or group; Dimitriadou, Maciejovsky, Wildschut, & Sedikides, 2019). Our nomothetic approach may explain the relatively modest levels of felt nostalgia elicited by the images in the nostalgia condition; for example, Harry Potter is likely nostalgic to many, but not all, participants in the sampled cohort. Future research 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 (Grzeschik et al., 2021; Hegarty, Montello, Richardson, Ishikawa, & Lovelace, 2006; Hilton et al., 2021; O'Malley et al., 2018; Richardson et al., 1999; Ruddle et al., 1997). However, follow-up work may examine if our findings are generalizable to more naturalistic virtual surroundings (e.g., indoor residences, outdoor urban landscapes; Davis, Ohman, & Weisbeck, 2017), real-world environments (Nolan, Mathews, Truesdale-Todd, & van Dorp, 2002), or a combination of the two (van der Ham, Faber, Venselaar, van Kreveld, & Löffler, 2015).

7.3. 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.

Author note

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Declaration of Competing Interest

We have no conflict of interest to declare.

Data availability

The data and analysis scripts are available on the Open Science Framework (link in article).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jesp.2023.104586.

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