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Personal and Collective Mental Time Travel Across the Adult Lifespan During COVID-19

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Older adults exhibit an *age-related positivity effect*, with more positivity for memories than young adults. Theoretical explanations attribute this phenomenon to greater emphasis on emotion regulation and well-being due to shortened time horizons. Adults, across the lifespan, also exhibit a *collective negativity bias* (more negativity about their country than their personal past and future) and a *future-oriented positivity bias* (more positivity for future projections than for memories). Threats to global health (e.g., the COVID-19 pandemic) may shorten future time horizons which may serve to impact emotional valence for memories and future projections. We investigated this possibility in 2020 during the COVID-19 pandemic in young, middle-aged, and older adults ($N = 434$; age: 18–81 years), for positive and negative events in the past (2019) and future (2021) in the personal and collective domains, as well as for future excitement and worry in these same domains in 1 week, 1 year, and 5–10 years' time. We replicated the collective negativity bias and future-oriented positivity bias, indicating the robustness of these phenomena. However, the pattern of age-related positivity diverged for personal events such that young adults exhibited similar positivity to older adults and more positivity than middle-aged adults. Finally, consistent with theoretical proposals of better emotion regulation with age, older adults reported more muted excitement and worry for the long-term future compared to young adults. We discuss the implications of this work for understanding valence-based biases in memory and future projections across the adult lifespan.

Public Significance Statement
This study examined how adults across the lifespan remembered their personal and country's past and predicted their personal and country's future during the COVID-19 pandemic. Unlike the typical positivity reported for older adults, young adults were just as positive as older adults and more positive than middle-aged adults about their personal past and future. Like prior research, people were more negative about their country than their personal past and future, and more positive about their country's future than its past. Overall, results suggest that people's feelings toward their personal and their country's past and future can differ across the adult lifespan during turbulent times.

Keywords: age differences, COVID-19, collective negativity bias, future positivity bias, age-related positivity effect

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The ability to imagine the future is closely linked to the ability to remember the past. Across the adult lifespan, people use memories and prior experiences to inform projections of the future. For instance, a young adult answering the common question "Where do you see yourself in 5 years?" might consider past schooling, promotions, and skills to imagine their future career path. An older adult answering the same question might consider experiences with social partners and favorite hobbies when imagining their upcoming retirement. The constructive process of imagining the future and the reconstructive process of remembering the past are

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An overview of the survey topics, the data analysis script, and processed data file are available on OSF at https://osf.io/tywsx/. Portions of these data were presented at the 2021 Meeting of the Psychonomic Society and the 2022 Cognitive Aging Conference.

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part of spontaneous thought (D'Argembeau et al., 2011) and have been called mental time travel (Tulving, 1985; see Schacter et al., 2008; Szpunar et al., 2014, for reviews).

Research has identified several key phenomena related to the emotional valence of mental time travel. For example, an *age-related positivity effect* has been observed for remembering the past such that older adults tend to remember more positive information relative to young adults (Mather & Carstensen, 2005; Reed & Carstensen, 2012; see Reed et al., 2014, for a meta-analytic review). Additionally, there is evidence for a *collective negativity bias* in mental time travel such that people exhibit less positivity when thinking about their country's past and future compared to their own personal past and future (Shrikanth & Szpunar, 2021; Shrikanth et al., 2018). Finally, researchers have observed evidence for a *future-oriented positivity bias* in mental time travel such that, overall, the future is projected to be more positive than the past (Grysman et al., 2015; Rasmussen & Berntsen, 2013; Shrikanth & Szpunar, 2021).

Our current understanding about the nature of personal and collective mental time travel comes primarily from research conducted under the typical conditions of life. Yet, human development is understood to proceed via interactions between persons and contexts (Bronfenbrenner, 1986), and the importance of considering environmental conditions for understanding developmental trajectories has recently been underscored (Drewelies et al., 2019). Given this, since little is known about how people think about the past and the future in unusual and intense contexts, the recent COVID-19 pandemic presents such a context to address this important question. In this study, we examined this significant context shift to characterize how adults across the lifespan engage in mental time travel during COVID-19 and whether age differences in emotional valence would emerge. We consider below the evidence and theoretical explanations for the three aforementioned effects, how they may differ across the adult lifespan, and how the experiences during the pandemic may reveal boundary conditions for these effects.

Age-Related Positivity Effect

Older adults typically remember more positive than negative information relative to young adults, and older adults also report less intensity for negative information than young adults (Mather & Carstensen, 2005; Reed & Carstensen, 2012; see Reed et al., 2014, for a meta-analytic review; see also Ford et al., 2021). This pattern has been called the age-related positivity effect and has been reported for past personal memories. Some studies also report that older adults exhibit more positivity relative to young adults for personal future projections as well, particularly when projecting to the same age (Durbin et al., 2019; Gallo et al., 2011; but see Kotter-Grühn & Smith, 2011). Older adults also exhibit better emotion regulation than young adults, even during challenging times (e.g., the COVID-19 pandemic; Carstensen et al., 2020). These patterns motivate the question of whether older adults will exhibit reduced emotional intensity due to their well-developed emotion regulation skill compared to young adults when rating their worry (negative valence) and excitement (positive valence) for the future. Finally, while less is known about the phenomenon of age-related positivity in midlife, some evidence suggests that this effect extends to middle age, with middle-aged adults recalling more positive information than young adults but less positive information than older adults (Fung et al., 2010; Li et al., 2011). To extend the literature regarding age-related positivity in middle age, we also investigated valence-based mental time travel in this age group.

A widely supported explanation for the age-related positivity effect comes from socioemotional selectivity theory (SST; Carstensen, 1993; Carstensen et al., 2003), which posits that as one's future time horizon becomes more limited, people become increasingly motivated to regulate negative emotions, maximize positive emotionality, and prioritize emotional well-being and gratification (Carstensen, 1993). As predicted by SST, when perceived future time horizons are restricted, people's behaviors shift to reflect goals associated with maximizing positivity. For example, when instructed to imagine a future with a very restricted time horizon, both young and older adults remembered more positive information than when imagining an expansive future (Barber et al., 2016). For both time horizons, the age-related positivity effect was nonetheless maintained such that older adults remained more positive than young adults. Together, these findings, along with predictions from SST (Carstensen, 1993), suggest that anyone who experiences a reduction to their future time horizon should exhibit enhanced positivity. This theoretical reasoning also suggests that real-world events that shorten perceived future time horizons, such as the COVID-19 pandemic (Rupprecht et al., 2022), could lead young adults, in addition to middle-aged and older adults, to favor positive information in memory and future projections even if older individuals remain more positive overall. These predictions have yet to be tested.

Collective Negativity Bias

Personal mental time travel differs in emotional valence from collective mental time travel (Shrikanth & Szpunar, 2021; Shrikanth et al., 2018). Specifically, people tend to predict more positive events for their personal future than their country's future when asked to generate events that they are excited or worried about (Shrikanth et al., 2018). People also remember personal events as being more positive than national events (Shrikanth & Szpunar, 2021). This collective negativity bias for future projections and memories has been observed for American and Canadian adults across genders, political affiliations, as well as a range of ages, suggesting that the pattern occurs across the adult lifespan for both events that participants report being excited and worried about in the future as well as other related tasks (Shrikanth et al., 2018; also see Topçu & Hirst, 2022). A candidate explanation for this effect is that national events that typically circulate from media outlets are negative in nature, making negative national events more accessible than positive national events (Shrikanth & Szpunar, 2021; Shrikanth et al., 2018; Soroka & McAdams, 2015), which could serve to impact negativity in both collective memories and collective future projections.

While the collective negativity bias extends across the adult lifespan (Shrikanth et al., 2018), it remains unclear whether age modulates collective mental time travel. That is, past work has not tested whether this bias interacts with age, raising the question as to whether the magnitude of the collective negativity bias differs across the adult lifespan. Yet, there is reason to expect that the extent of collective negativity bias may vary as a function of age. Notably, older adults think less about their personal future and instead devote more attention to the collective (Carstensen & Chi, 2021; Fung et al., 2016; Raposo et al., 2021). This pattern has been linked to motivating collective action for the greater good in older-aged

individuals (K. K. Szpunar et al., 2020; see also Bailey et al., 2021; Sparrow et al., 2021). While older adults are expected to exhibit negativity for national events compared to personal events in accordance with the collective negativity bias (Shrikanth et al., 2018), the magnitude of this bias may be less than the bias exhibited by young adults, another prediction that is yet to be tested.

In this context, an important question that motivated the present study was whether the collective negativity bias would persist during the COVID-19 pandemic. On the one hand, the pandemic dominated the national news cycle in 2020 with an overwhelming amount of worrisome information and "bad news," and exposure to negative media has been suggested as the basis for the collective negativity bias (Shrikanth et al., 2018). On the other hand, some of the messaging around COVID-19 encouraged people of all ages to engage in health-related behaviors for the collective good (e.g., an ad produced by the Health and Human Services division of the U.S. Department of Health and Human Services, 2021, containing the slogan "We can protect each other."). This shift to a prosocial orientation focused on encouraging behaviors for the welfare of others (Bailey et al., 2021), similar to what has been observed for older adults in more typical times (Sparrow et al., 2021; K. K. Szpunar et al., 2020), may attenuate the typical collective negativity bias for all age groups. We tested the theoretical predictions about prosociality typically associated with older adults in the context of prosociality encouraged for all age groups during COVID-19, when this study was conducted.

Future-Oriented Positivity Bias

Generally, people are more positive about the future than about the past. This future-oriented positivity bias has been observed in both the personal future (Grysman et al., 2015; Rasmussen & Berntsen, 2013) and collective future (Cabecinhas et al., 2011; cf. Ionescu et al., 2022; Shrikanth & Szpunar, 2021; Topçu & Hirst, 2020; Yamashiro & Roediger, 2019).

Although memories of the past are known to inform future projections to some extent (Johnson & Sherman, 1990), theoretical explanations for why the future is viewed more positively than the past posit that memories for past events are constrained by the reality of how events unfolded, and this process necessarily differs from constructions of future events where more latitude is possible in our thinking (e.g., Rasmussen & Berntsen, 2013). For example, the answer to the question "Where do you see yourself in 5 years?" can involve imagining family events, career advancement, and important national events, whereas the answer to the question "Where were you 5 years ago?" is necessarily constrained by reality. Positive personal future projections are thought to help people see themselves on an upward trajectory (Rasmussen & Berntsen, 2013; Salgado & Berntsen, 2020), and people also feel that they have more control over the collective future than the past and can therefore shape the collective future to be more positive (Topçu & Hirst, 2020).

It is not yet clear whether age impacts the magnitude of the future-oriented positivity bias, although there is good reason to think that it should. For instance, older adults are generally less optimistic compared to young adults when they are asked to imagine their personal future over unspecified or distant time horizons where older adults are necessarily projecting to older ages than young adults (e.g., 15 years into the future; Chessell et al., 2014; Durbin et al., 2019; Kotter-Grühn & Smith, 2011; Ryff, 1991). By contrast, limitations to older adults' personal future time horizons may be less important for shaping the valence of thinking in the collective domain, and older adults' increased motivation to engage in prosocial action for the greater good (Bailey et al., 2021; Sparrow et al., 2021; K. K. Szpunar et al., 2020) may result in older adults exhibiting more positivity for the future relative to young and middle-aged adults. The COVID-19 period provided an important test of these theoretical bases, to the extent that the negative prevailing conditions during this study may modulate the valence of future projections.

The Present Study

The three patterns in mental time travel that we just described—the age-related positivity effect, collective negativity bias, and future-oriented positivity effect—were observed before the COVID-19 pandemic. However, the COVID-19 period has been characterized by significant disruptions to daily life, health threats, and uncertainty around the future. Therefore, investigating the valence of mental time travel during this period affords an important opportunity to test the theoretically derived predictions outlined above and to identify potential boundary conditions on these effects.

How might the COVID-19 pandemic influence mental time travel? With respect to the age-related positivity effect, we examined whether the effect emerges under circumstances that highlight life's fragility for adults across the lifespan. Previous work suggests that when future time horizons are restricted, both young and older adults report enhanced positivity in memory (Barber et al., 2016). Given that the COVID-19 pandemic posed a significant threat and reduced future time perspectives for adults across the lifespan (Rupprecht et al., 2022), in our study, young, middle-aged, and older adults were all expected to exhibit a positivity bias (i.e., more positivity than negativity) in mental time travel. While SST (Carstensen, 1993) would predict a continuation of the age-related positivity effect, it remains to be seen whether the age-related positivity effect emerges for remembering the past and imagining the future in the personal and collective domains under such extreme real-world conditions.

Turning to the collective negativity bias, we examined whether this effect emerged in the context of the COVID-19 pandemic and if the magnitude of the effect differed between young, middle-aged, and older adults. Given that negative news media coverage is thought to contribute to the collective negativity bias (Shrikanth et al., 2018) and the extensive coverage of the pandemic and its negative consequences that dominated the news media during this time, we expected to observe the collective negativity bias in our study. However, alternative theoretical predictions can be made regarding the collective negativity bias as indexed by excitement and worry ratings for older adults in the context of the COVID-19 pandemic. On the one hand, older adults tend to be more positive than young and middle-aged adults when remembering the personal past, even during the pandemic (e.g., the age-related positivity effect; Ford et al., 2021; Reed & Carstensen, 2012), and they often attend to collective over personal goals (K. K. Szpunar et al., 2020). These patterns suggest that older adults may exhibit a reduced collective negativity bias compared to middle-aged or young adults. On the other hand, negative news media coverage related to the pandemic was often focused on threats to older adults (e.g., Graham, 2020; Kopecki et al., 2020). Because negative news media coverage of national events has been proposed as the theoretical basis for the collective negativity bias (Shrikanth et al., 2018), this consideration may lead older adults to exhibit more collective negativity than middle-aged or young adults

in the context of COVID-19, when negative news media was particularly focused on threats to older-aged groups.

Finally, with respect to the future-oriented positivity bias, we investigated whether the COVID-19 pandemic might alter this pattern given the negative backdrop of the pandemic against which people would be making future predictions. We also sought to establish whether the extent of this bias varied across age groups (young, middle-aged, and older adults) and domains (personal and national) under the pandemic context. Older participants typically exhibit less optimism toward their personal future for long or unspecified future time horizons (Durbin et al., 2019). If this pattern holds in the present study, then older adults would be expected to exhibit reduced future-oriented positivity compared to other age groups in the personal domain. In the collective domain, older adults' prepandemic motivation to engage in collective action for the greater good (K. K. Szpunar et al., 2020) might lead them to exhibit an enhanced future-oriented positivity bias for collective mental time travel compared to younger groups.

To evaluate the aforementioned theoretical proposals surrounding age differences in mental time travel during the COVID-19 pandemic, we administered a survey to participants in the United States in the Summer and Fall 2020. In our mental time travel task, participants provided short descriptions of positive and negative events for the near past (2019) and near future (2021) in the personal and national domains. This task allowed us to assess valence-based biases that participants may exhibit when remembering the past and imagining the future in the personal and collective domains, respectively, and to characterize the extent of any biases observed across the adult lifespan. We further asked participants to report their general feelings of excitement (positive valence) and worry (negative valence) about the personal and national future in 1 week, 1 year, and 5–10 years' time. This task allowed us to capture the intensity of valence in future-oriented thinking for adults of different ages in the personal and collective domains at a variety of future time horizons, including a more distant time horizon (i.e., 5–10 years). It also allowed us to test the intensity of excitement and worry for all participants, a particularly interesting question for older adults due to their well-developed emotion regulation skill (Carstensen et al., 2020; Charles & Carstensen, 2014; Charles et al., 2003).

Method

Transparency and Openness

We follow *Journal Article Reporting Standards* guidelines (Appelbaum et al., 2018) for reporting sample size, measures, and data exclusions. Analyses were conducted in *RStudio* (RStudio Team, 2020) using the *WelchADF* package (Villacorta, 2017), and graphs were generated with *ggplot2* (Wickham et al., 2016). Study design and analyses were not preregistered. Survey topics, processed data, and analysis code are available on the Open Science Framework (Foster & Deardorff, 2017).

Participants

Participants were undergraduate psychology students from Stony Brook University (Sona), Amazon Mechanical Turk (MTurk) workers, and members of the Stony Brook University Osher Lifelong Learning Institute (OLLI) program in the United States. We recruited participants from various platforms to diversify our sample, including for age range, and to strive for generalizability of our findings (Walters et al., 2018). Undergraduate participants were granted course credit, while all other participants (MTurk workers, OLLI members) were paid $4.50 U.S. Dollars. Procedures were reviewed and approved by the Stony Brook Institutional Review Board (MOSAIC, No. IRB2020-00307).

Our survey was available between August 11, 2020, and October 10, 2020. We recruited 520 participants and excluded 86 participants from the final sample for the following reasons: Fifty participants did not report if they were Sona, MTurk, or OLLI participants (and therefore the appropriate compensation type could not be determined), three were not comfortable with English, 13 completed the survey outside of the United States, 17 completed the survey multiple times (their first response was retained for analysis), one was a bot, one was an outlier on the basis of survey duration, and one failed to report their age.

In our final sample of 434 participants, there were 241 young adults (17–30 years of age), 138 middle-aged adults (31–54 years of age), and 55 older adults (55+ years of age). Most of our young adult sample was recruited via SONA (90.04%), whereas our middle-aged (99.27%) and older adult groups (65.45%) were primarily recruited via MTurk. In the older adult group, 28 participants (50.90%) were 65 years or older. Of our final sample of 241 young adults, 106 (43.98%) identified as White, 91 (37.77%) as Asian, 19 (7.88%) as Black/African American, 11 (4.56%) as "other," 10 (4.15%) as mixed, 2 (0.83%) as Native American/Alaskan Native, and two (0.83%) did not report their race. Thirty-six (14.94%) young adults identified as Latino/Hispanic. Of our final sample of 138 middle-aged adults, 118 (85.51%) identified as White, 15 (10.87%) as Black/African American, and five (3.62%) as Asian. Five (3.62%) middle-aged adults identified as Latino/Hispanic. Last, in our sample of 55 older adults, 53 (96.36%) identified as White and two (3.63%) identified as Black/African American, and none as Latino/Hispanic.[1]

Materials and Procedure

Data included in this study were collected as a part of a large-scale survey that took approximately 45 min to complete. Survey probes relevant to the data reported in this article are described below; probes not addressed here are not described further.

Mental Time Travel Task

We adapted and modified questions from Shrikanth et al. (2018) to probe personal and national mental time travel. Participants were asked to (a) *recollect* positive and negative *personal* events from 2019, (b) *recollect* positive and negative *national* events from 2019, (c) *predict* positive and negative *personal* events in 2021, and (d) *predict* positive and negative *national* events in 2021. Participants also ranked the reported events according to perceived emotional significance. Prompts were phrased as follows:

[1] Overall, our racial distribution differed across age groups. To address this potential confound, we conducted an analysis to examine potential differences in our young and middle-aged adult groups by race in the mental time travel task. Responses did not significantly differ by race, and no Age × Race interaction was observed (see supplemental materials, for additional details regarding this analysis).

[Positive/Negative] [Personal/National] events in [2019/2021]: In 10 words or less for each event, please list 3–5 [positive/negative] events that come to mind easily [that occurred/that you expect to occur] in [2019/2021] from most emotionally significant to least emotionally significant (1 = most significant).

Participants had 90 s per prompt to report and rank up to five events. Significance rankings are not considered under the current analyses. Prompts were presented in chronological order by year to avoid participants mistakenly responding to an incorrect prompt (cf. Shrikanth et al., 2018).

Scoring Protocol. To evaluate the extent to which participants were more positive or more negative during mental time travel, we subtracted the number of negative events reported within a prompt from the number of positive events from the same year and domain (e.g., 2019 positive national–2019 negative national). The use of difference scores for these data allowed us to capture the valence-based bias that participants were exhibiting in terms of mental time travel. Positive scores indicated a positive bias, and negative scores indicated a negative bias. Scores of zero indicated no valence-based bias for mental time travel. We report the average number of positive and negative events generated for each category (e.g., 2019 national, 2019 personal) in our supplemental materials across age groups (see Table S1). This analysis included 433 participants.

Future Excitement and Worry Task

We adapted this task from a procedure originally described by MacLeod and colleagues (MacLeod & Byrne, 1996; MacLeod et al., 1997) for use in patient populations to probe anticipated future events. It has been used more recently to assess collective future thinking in nonclinical samples (Shrikanth et al., 2018) by asking participants to list events that they were excited/worried about in the future. We adapted this task by asking participants to provide ratings for future excitement/worry, giving us a measure of intensity of these feelings. In our study, participants responded to a series of questions related to excitement and worry about their personal and the national future in 1 week, 1 year, and 5–10 years' time. Participants rated how (a) excited they were about their personal future, (b) how excited they were about their nation's future, (c) how worried they were about their personal future, and (d) how worried they were about their nation's future within each of the three time frames so that they provided 12 ratings overall. The prompt read as follows, "Choose a value ranging from 0 (*not at all [excited/worried]*) to 10 (*very [excited/worried]*) to represent how [excited/worried] you feel about your [personal/country's]) future." Participants completed these tasks within 2 min.

Excitement and worry ratings were considered separately because we wanted to examine the intensity of participants' future excitement and worry. While using subtraction for the number of positive and negative events in the mental time travel task described above provides information about the direction of valence-based biases in mental time travel, the use of a subtraction method here could overshadow the intensity of excitement and worry in future thinking.

Results

We first examined mental time travel as a function of age group (young vs. middle-aged vs. older adults), domain (personal vs. national events), and year (past: 2019 vs. future: 2021) on the difference score between the number of positive and negative events reported for each prompt. Next, we assessed the effects of age group, domain, and timeline (1 week, 1 year, 5–10 years in the future) for future excitement and worry ratings separately.

As the data violated the assumptions of normality and homogeneity of residuals for conducting a standard analysis of variance (Glass et al., 1972), we used the Welch–James statistic with approximate degrees of freedom (ADF) to test group differences (Johansen, 1980; Villacorta, 2017). Pairwise contrasts were corrected using the Hochberg procedure (Hochberg & Tamhane, 1987), and partial omega-squared (ω_p^2) effect sizes are reported (Keppel, 1991; Keren & Lewis, 1979). Test statistics for all analyses are reported in Tables 1–4. With 434 participants (241 young adults, 138 middle-aged adults, and 55 older adults), the present study achieved 80% power to detect effect sizes of $\omega_p^2 = 0.006$ (partial Cohen's $f = 0.075$) or greater.

Mental Time Travel

To examine the effects of age group (young adults vs. middle-aged adults vs. older adults), domain (personal vs. national), and year (2019 vs. 2021) on the valence of events reported during mental time travel, we conducted a three-way Welch ADF test (see Table 1). Of particular interest, results revealed a significant main effect of domain such that participants were overall less positive in the collective than in the personal domain consistent with the collective negativity bias reported in prepandemic literature. However, this effect was moderated by age and year in the significant three-way interaction (Figure 1). As such, we followed it up by examining interactions between age group and year in the personal domain and the collective domain separately.

In the personal domain (see Figure 1, left panel, and Table 1), there was no significant interaction between age group and year nor a main effect of year, but there was a significant main effect of age group. Follow-up comparisons revealed that young adults (M_y = 0.81, SD_y = 1.58) exhibited similar positivity to older adults (M_o = 0.76, SD_o = 1.62) and greater positivity than middle-aged adults (M_m = 0.45, SD_m = 1.42). Middle-aged adults did not significantly differ from older adults in terms of overall positivity.

In the national domain (see Figure 1, right panel, and Table 1), we observed a significant interaction between age group and year. Follow-up comparisons examining the effect of year were significantly more positive about the collective future than about the collective past among all age groups. These findings show an overall pattern across age that is consistent with the future-oriented positivity bias, which is notably larger among middle-aged and older adults compared to young adults.

To supplement these analyses, we thematically coded the events that participants reported. Overall, similar types of events were reported across age groups, year, domain, and valence, suggesting that age differences described above are based on differences in the number, but not types, of positive and negative events (see supplemental materials).

Together, findings from the mental time travel task did not reveal an age-related positivity effect in the personal domain, as young adults were just as positive as older adults and more positive than middle-aged adults overall, collapsing across recall of the personal past and projections into the personal future. For collective future thinking, we observed evidence for age-related positivity, demonstrating this phenomenon reported in previous research for memories of the

Table 1
Mental Time Travel Results

Effect	Between *degrees of freedom*	Within *degrees of freedom*	*Welch-James statistic*	*p*	ω_p^2
Age	2	546.00	3.25	.039	.01
Domain	1	441.80	57.71	<.001	.12
Year	1	441.80	10.99	<.001	.02
Domain × Year	1	441.00	28.23	<.001	.06
Age × Domain	2	546.00	1.63	.196	.003
Age × Year	2	546.00	0.27	.759	−.003
Age × Domain × Year	2	546.00	6.89	<.001	.03
Personal domain follow-up					
Age	2	286.80	5.17	.006	.019
Year	2	242.50	2.34	.127	.003
Age × Year	2	286.80	2.86	.059	.009
Age comparisons in personal domain					
Young vs. middle	1	609.20	9.76	.006	.023
Young vs. old	1	161.60	0.06	.797	−.003
Middle vs. old	1	181.10	3.07	.163	.011
National domain follow-up					
Age	2	275.80	0.18	.832	−.004
Year	1	217.40	32.46	<.001	.07
Age × Year	2	275.80	4.09	.002	.014
Simple effect of year in national domain					
Young	1	382.80	4.03	.045	.012
Middle	1	260.00	26.66	.001	.157
Old	1	104.70	11.49	.001	.160

Note. Results of omnibus and follow-up analyses examining valence in mental time travel as a function of age group, domain, and year. vs. = versus.

personal past in collective future thinking. In addition, we replicated a future-oriented positivity bias in the collective domain for all age groups, with participants across the adult lifespan being more positive about the national future than the national past.

Future Excitement and Worry

To evaluate whether age differences emerged in terms of general excitement and worry for the future, we conducted an age group (young vs. middle-aged vs. older adults) by rating type (excitement vs. worry) Welch ADF test (see Table 2) for mean excitement and worry ratings (collapsed across domain and timeline). There was a significant effect of age group and a significant effect of rating type. Collapsing across excitement and worry, young adults (M_y = 5.58, SD_y = 1.91) exhibited significantly more intense ratings for both excitement and worry about the future compared to both middle-aged (M_m = 4.67, SD_m = 2.02) and older adults (M_o = 4.91, SD_o = 2.00). Middle-aged and older adults did not differ in their ratings for the future. The age group by rating type interaction was not significant. In general, people expressed more worry (M = 5.56, SD = 1.96) than excitement (M = 4.85, SD = 1.97) for the future.

Excitement

We examined whether excitement about the future varied as a function of age group (young vs. middle-aged vs. older adults), domain (personal vs. national), and timeline (1 week vs. 1 year vs. 5–10 years). The Welch ADF test revealed significant age group by domain and age group by timeline interactions. Neither the three-way interaction nor the domain by timeline interaction reached significance (see Table 3).

We followed up the significant age group by domain interaction (collapsed across timeline) to examine the simple effect of domain at

Table 2
Future Excitement and Worry Ratings by Age Group

Effect	Between *degrees of freedom*	Within *degrees of freedom*	*Welch-James statistic*	*p*	ω_p^2
Age group	2	285.60	20.28	<.001	0.082
Rating type	1	263.30	22.54	<.001	0.047
Age Group × Rating Type	2	285.60	0.34	.710	−0.003
Age follow-up					
Young vs. middle-aged	1	536.60	37.36	<.001	.088
Young vs. old	1	156.90	10.57	<.001	.031
Middle-aged vs. old	1	201.00	1.09	.298	<.001

Note. Results of omnibus examining age differences in terms of general excitement and worry for the future (collapsed across domain and year). vs. = versus.

Table 3
Excitement for the Future Results

Effect	Between *degrees of freedom*	Within *degrees of freedom*	*Welch-James statistic*	*p*	ω_p^2
Age	2	850.50	32.82	<.001	.138
Domain	1	825.30	46.51	<.001	.09
Timeline	2	533.70	160.06	<.001	.42
Domain × Timeline	2	553.70	0.52	.593	−.002
Age × Domain	2	850.50	4.15	<.001	.014
Age × Timeline	4	642.20	5.70	<.001	.042
Age × Domain × Timeline	4	642.20	1.15	.332	.001
Age by domain follow-up					
Young: Personal vs. national	1	1375.0	58.01	<.001	.19
Middle-aged: Personal vs. national	1	813.60	13.64	<.001	.084
Older: Personal vs. national	1	323.40	2.97	.086	.035
Age by timeline follow-up					
1 Week	2	298.40	1.919	.140	.004
1 Year	2	299.60	13.12	<.001	.053
Young vs. middle-aged	1	556.70	23.63	<.001	.056
Young vs. older	1	173.00	8.51	.008	.020
Middle-aged vs. older	1	221.30	0.66	.419	−.002
5–10 Years	2	293.30	28.70	<.001	.110
Young vs. middle-aged	1	544.00	46.92	<.001	.110
Young vs. older	1	165.40	24.27	<.001	.070
Middle-aged vs. older	1	214.80	0.06	.800	−.005

Note. Results of omnibus examining excitement for the future as a function of age group, domain, and year. Follow-up analyses are also included. vs. = versus.

each age level (see Figure 2). Young and middle-aged adults were significantly less excited about the national future than the personal future, replicating the collective negativity bias (Shrikanth et al., 2018) in young adults and extending it to middle-aged adults. For older adults, the simple effect of domain was not significant, indicating no difference in excitement for their personal versus national future. This pattern is consistent with past findings to the extent that older adults have been reported to view the collective future in the context of their personal future (K. K. Szpunar et al., 2020) and consistent with older adults' well-developed emotion regulation skills (Carstensen et al., 2020; Charles & Carstensen, 2014; Charles et al., 2003).

We followed up the significant age group by timeline interaction (collapsed across domain), with a simple effect of age group at each

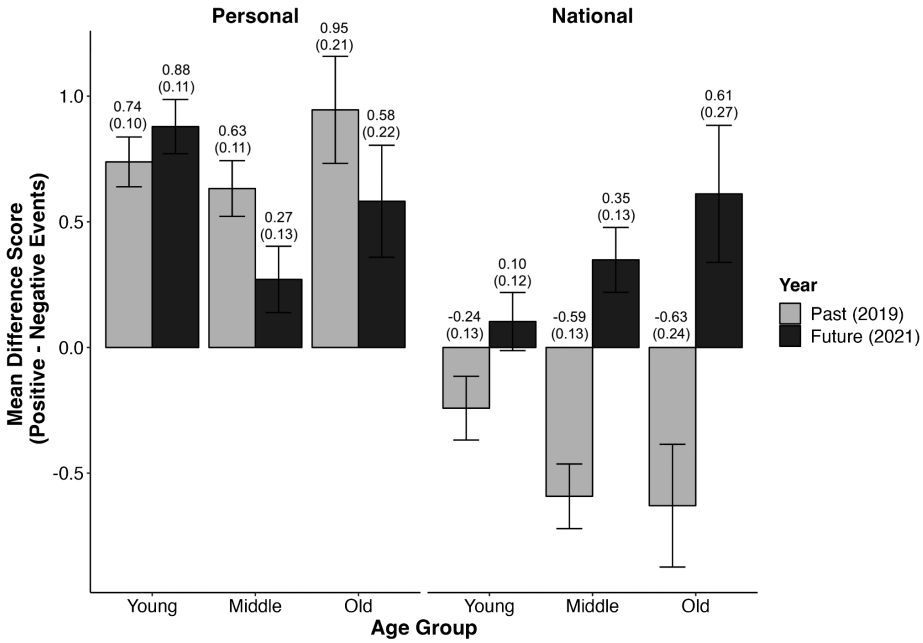
Table 4
Worry for the Future Results

Effect	Between *degrees of freedom*	Within *degrees of freedom*	*Welch-James statistic*	*p*	ω_p^2
Age	2	830.00	20.31	<.001	.08
Domain	1	774.80	82.14	<.001	.16
Timeline	2	520.50	22.81	<.001	.09
Domain × Timeline	2	520.50	5.20	.016	.019
Age × Domain	2	830.00	1.40	.247	.002
Age × Timeline	4	627.00	4.49	<.001	.031
Age × Domain × Timeline	4	627.00	0.33	.855	−.006
Age by timeline follow-up					
1 Week	2	288.30	0.74	.479	−.001
1 Year	2	287.40	9.55	<.001	.038
Young vs. middle-aged	1	578.80	18.97	<.001	.045
Young vs. older	1	161.00	2.56	.147	.005
Middle-aged vs. older	1	194.60	2.12	.147	.006
5–10 Years	2	286.80	18.80	<.001	.076
Young vs. middle-aged	1	563.40	32.17	<.001	.076
Young vs. older	1	159.40	14.11	<.001	.042
Middle-aged vs. older	1	197.20	0.10	.755	−.005
Domain by timeline follow-up					
1 Week: Personal vs. national	1	829.70	47.33	<.001	.096
1 Year: Personal vs. national	1	837.80	55.17	<.001	.111
5−10 Years: Personal vs. national	1	839.40	7.14	.008	.014

Note. Results of omnibus examining worry for the future as a function of age group, domain, and year. Follow-up analyses are also included. vs. = versus.

Figure 1

Valenced-Based Personal and National Mental Time Travel Across Age Groups



Note. This figure depicts the difference in the number of positive and negative events reported for the personal 2019, personal 2021, national 2019, and national 2021 prompts as a function of age. Negative difference scores indicate that participants recalled more negative than positive events on average and positive scores indicate that participants recalled more positive than negative events on average. Error bars represent standard errors. Means and (standard errors) are labeled above each bar.

time point (see Figure 3). There were no age differences for 1 week into the future. Conversely, we observed that for 1 year into the future young adults reported significantly more excitement than both middle-aged and older adults. This pattern was also observed for 5–10 years into the future such that young adults were more excited than middle-aged and older adults. Middle-aged and older adults' excitement did not differ at 1 year or 5–10 years into the future. In brief, at longer time frames, excitement decreased with age, a pattern consistent with the effects of a more limited time horizon with age (Durbin et al., 2019).

Worry

Last, we examined whether worry for the future varied as a function of age group (young adults vs. middle-aged adults vs. older adults), domain (personal vs. national), and timeline (1 week vs. 1 year vs. 5–10 years). The Welch ADF test (see Table 4) revealed a significant age group by timeline and domain by timeline interactions. The age group by domain interaction and the three-way interaction were not significant.

The age group by timeline interaction indicated that (as with excitement) age difference in worry increased with projection into the future (see Figure 4). One week into the future, there were no significant age differences in worry. For 1 year into the future, pairwise contrasts revealed significantly higher worry among young adults than middle-aged adults, but no differences were observed between young and older adults or middle-aged and older adults. For 5–10 years into the future, pairwise contrasts revealed significantly greater worry for young adults compared to both middle-aged and older adults. Middle-aged and older adults did not differ in their worry ratings. The age-related patterns reported here are similar to the pattern observed for excitement ratings at one and 5–10 years time horizons and may again reflect the impact of increasingly limited time horizons with aging (Durbin et al., 2019) due to the fact that older adults are necessarily thinking about different stages of life compared to the younger aged groups.

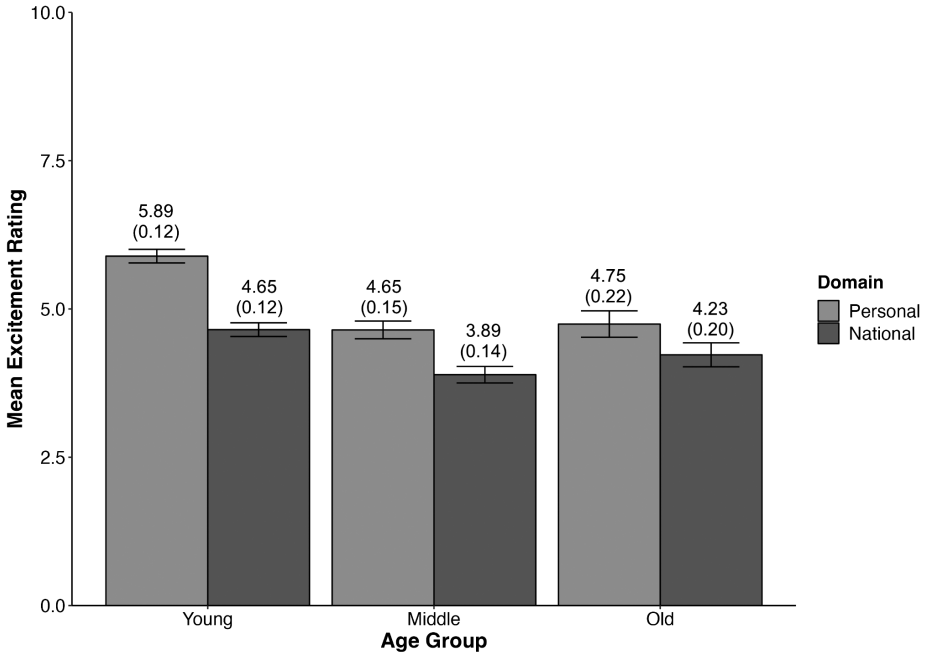
For the significant domain by timeline interaction (collapsed across age, see Figure 5), follow-up comparisons examining the effect of domain across all levels of timeline revealed a collective negativity bias. Participants were significantly more worried about the national future than the personal future at each time point, though this difference was smallest at the longest time horizon, suggesting hazier conceptualization of these differences for distant time points. At the same time, the extent of the collective negativity bias did not vary with age; participants across all age groups reported more worry for the collective future ($M_y = 6.34$, $SD_y = 2.93$; $M_m = 5.72$, $SD_m = 2.64$; $M_o = 6.09$, $SD_o = 2.54$) than for the personal future ($M_y = 5.41$, $SD_y = 3.01$; $M_m = 4.44$, $SD_m = 3.00$; $M_o = 4.72$, $SD_o = 2.96$).

Future Excitement and Worry Task Summary

Overall, the future excitement and worry task showed that all age groups were more worried about the collective than personal future, again indicating a collective negativity bias consistent both with our analyses of the mental time travel task and prior literature. Interestingly, young adults were both more excited and more worried

Figure 2

Excitement for the Future Across Age and Domain



Note. This figure depicts the significant age by domain interaction for excitement ratings and shows how excited participants were for their personal and national future across age (collapsed across time). Error bars represent standard errors. Means and (standard errors) are labeled above each bar.

about the distant future (i.e., 5–10 years) across both domains (i.e., personal, collective) than older-aged participants. For the excitement ratings, while young and middle-aged adults were more excited about the personal future than the collective future, older adults were just as excited about the personal and collective future. In general, the patterns that emerged for greater intensity in young adults in both worry and excitement ratings relative to middle-aged and older adults are consistent with increased emotion regulation with age (Carstensen et al., 2020; Charles & Carstensen, 2014; Charles et al., 2003).

Discussion

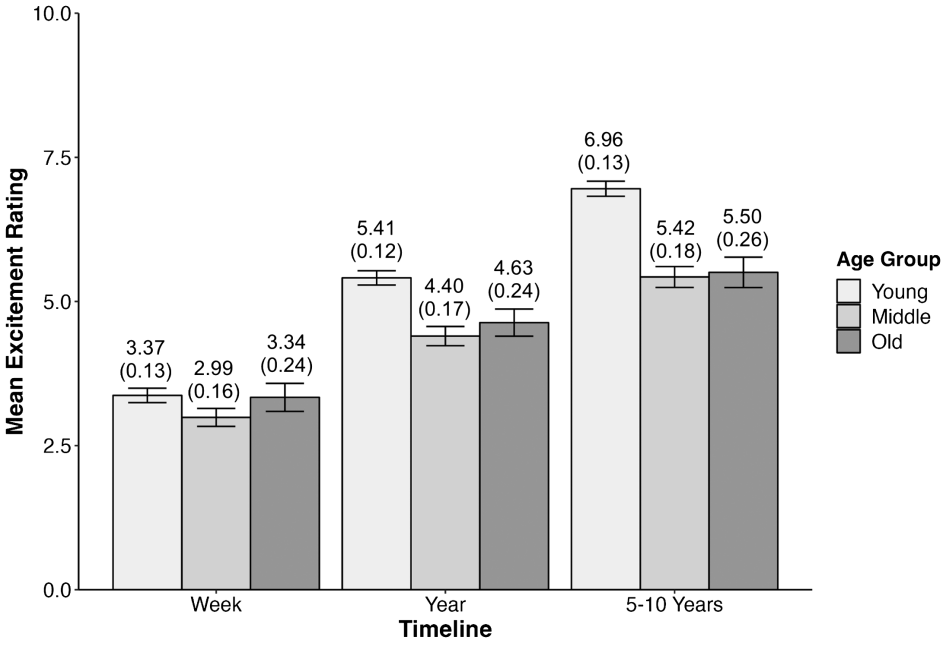
In the present study, we probed age differences in mental time travel during the unprecedented and unusual lived experiences of the COVID-19 pandemic. Specifically, we focused on three key phenomena reported in prior literature: the collective negativity bias, the future-oriented positivity bias, and the age-related positivity effect. We investigated these effects for personal and collective mental time travel in young adults, older adults, and the lesser studied group of middle-aged adults (Lachman, 2015).

We observed replications of several valence-based findings reported in studies prior to the pandemic. Specifically, we observed a collective negativity bias across all tasks and age groups. Participants reported more negative national events than negative personal events for the mental time travel task (see Figure 1) and were less excited and more worried about the country's future than their personal future (see Figures 2 and 5, respectively). The persistence of the collective negativity bias during the pandemic shows that, despite the personal upheaval caused by COVID-19 and other notable events that occurred in 2020 and dominated the news (Shrikanth et al., 2018), participants felt more positively about personal events compared to national events. It is worth noting, however, that older adults did not exhibit a collective negativity bias in the context of excitement for the future, instead exhibiting similar levels of excitement in the national and personal domains. This pattern of results may be due to older adults' increased motivation to engage in collective action for the greater good (K. K. Szpunar et al., 2020; see also Bailey et al., 2021; Sparrow et al., 2021).

Turning to the future-oriented positivity bias, in the mental time travel task, all age groups exhibited this bias in the collective domain, again replicating past literature (Shrikanth & Szpunar, 2021; Shrikanth et al., 2018). Here, participants reported more positive events for the national future than the national past. The fact that participants were optimistic about the national future (compared to the national past) even during the COVID-19 pandemic may seem somewhat surprising. However, our findings suggest that a general sense of optimism for the future (Rasmussen & Berntsen, 2013) holds even during challenging times. For example, people may have viewed the future optimistically with considerations about travel becoming available again (Wang & Xia, 2021). Likewise, even in the context of the pandemic, people may be more optimistic about the collective future because they expect to have more control over the future than in the past (Topçu & Hirst, 2020). At the same time, while all age groups exhibited the future-oriented positivity bias in the collective domain, the size of this effect was larger for middle-aged and older adults, suggesting an age-related positivity effect in collective future thinking, perhaps due to older individuals' propensity to engage in collective action for the greater good (K. K. Szpunar et al., 2020).

Figure 3

Excitement for the Future Across Age and Timeline

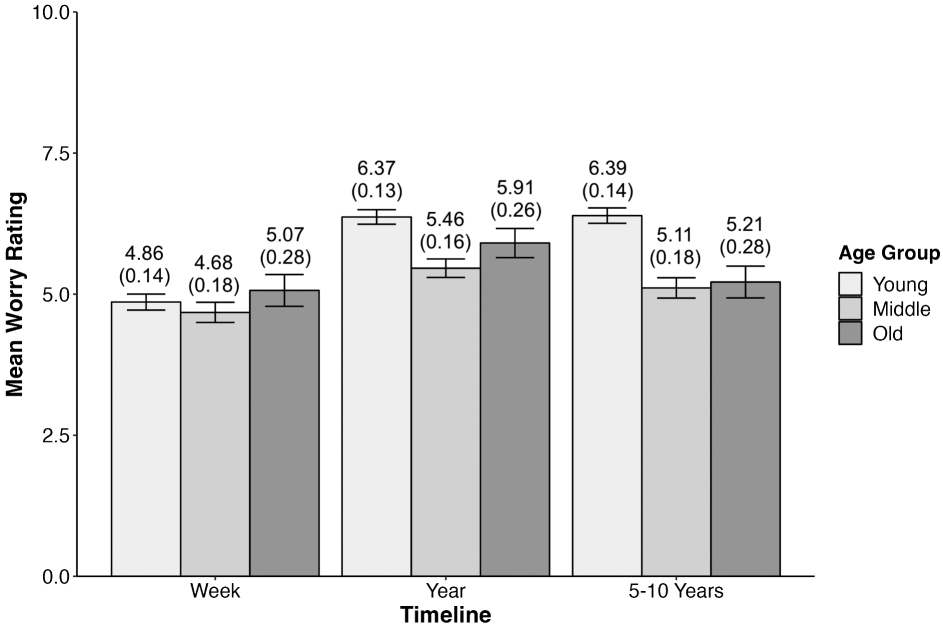


Note. This figure depicts the significant age by timeline interactions (collapsed across domains) for excitement ratings. Error bars represent standard errors. Means and (standard errors) are labeled above each bar.

In the personal domain for the mental time travel task, the future-oriented positivity bias did not emerge as there was no difference in the number of positive events reported between the past and the future. Interestingly, only young adults exhibited the expected numeric pattern of greater positivity for the future compared to the past, with middle-aged and older adults showing the opposite numerical trend. For middle-aged adults, burdens of the "sandwich generation" (Miller, 1981; Wiemers & Bianchi, 2015), exacerbated

Figure 4

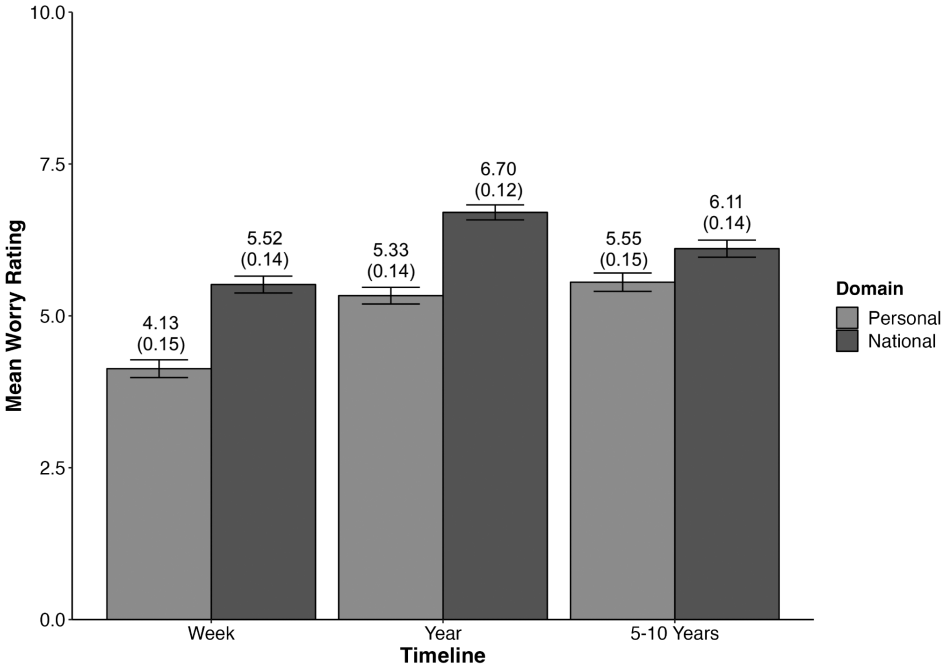
Worry for the Future Across Age and Timeline



Note. This figure depicts the significant age by timeline interactions (collapsed across domains) for worry ratings. Error bars represent standard errors. Means and (standard errors) are labeled above each bar.

Figure 5

Worry for the Future Across Domain and Timeline



Note. This figure depicts the significant domain by timeline interaction (collapsed across age) for worry. Greater worry in the collection domain (national), is consistent with the collective negativity bias. Error bars represent standard errors. Means and (standard errors) are labeled above each bar.

during the pandemic (Park, 2021; Stokes & Patterson, 2020), likely contributed to this pattern. This is generally consistent with affective patterns observed prior to the COVID-19 pandemic for middle-aged adults (Grühn et al., 2010). However, it is not consistent with the tenets of SST in that middle-aged adults have shorter time horizons than young adults and are therefore expected to exhibit more positivity for memories of the past, although literature to this point is sparse (Fung et al., 2010; Li et al., 2011). Our findings motivate future tests for whether muted positivity in middle-aged adults emerged due to the particularly negative backdrop and the additional age-dependent pressures of the pandemic, or whether the previously observed patterns in middle age for memories of the personal past do not extend to future thinking. The failure to observe the typical pattern of future-oriented positivity among older adults is somewhat consistent with prepandemic reports of reduced optimism for future mental time travel (Durbin et al., 2019), though the reason why this effect emerges for the near-term future (e.g., 2021) under the COVID-19 context that presented more constrained time horizons for all is less clear.

With respect to the age-related positivity effect, results from the mental time travel task revealed a departure from the typical finding of greater positivity in older adults relative to younger age groups in the personal domain. While all adults reported more positive than negative events in their personal mental time travel, young adults were more positive than middle-aged adults and exhibited similarly high levels of positivity to older adults (see Figure 1, left panel). This pattern was unexpected in the context of the SST framework, which predicts that older adults should exhibit more positivity than both young and middle-aged adults given their more restricted time horizons (e.g., Barber et al., 2016; Fung et al., 2010; Li et al., 2011). Two explanations may account for this outcome. One possibility is that COVID-19 constituted a significant health threat to all age groups during the period when this study was conducted and perhaps served to shorten future time horizons (cf. Ford et al., 2021; Rupprecht et al., 2022), which in turn may have resulted in higher than typical levels of positivity for young adults (Barber et al., 2016). This explanation aligns with findings suggesting that shortened future time horizons shift social preferences such that young adults prefer to spend time with close friends and family much like older adults under typical circumstances (e.g., Fung & Carstensen, 2006; Jiang & Carstensen, 2023). Given that relatively fewer studies examining the age-related positivity effect have included middle-aged adults and those that have focused on the personal past (Fung et al., 2010; Li et al., 2011), it is unclear why middle-aged adults were less positive than young adults in this context. Likewise, under this explanation, it is unclear why older adults did not exhibit more positivity than young adults, as was observed by Barber et al. (2016). Importantly, however, our data were not experimentally derived and instead relied on naturally occurring circumstances. Further, we probed personal mental time travel for the past and future rather than focusing firmly on memory for positive and negative items from the past as in Barber et al. (2016).

Another possible explanation as to why we did not observe the age-related positivity effect in the personal domain is that, in reflecting on the past and projecting plausible future events, such as vaccines becoming available, lockdowns being lifted, and social gatherings becoming possible, young and older adults may have both remembered and envisioned the possibility of more freely pursuing their respective priorities (an option that is less likely for

middle-aged adults due to their "sandwich generation" responsibilities Miller, 1981; Wiemers & Bianchi, 2015). For example, young adults could recall and imagine in-person classes and making new friends, whereas older adults could think back to and imagine meeting up with family and old friends. Importantly, while we observe a fair degree of consistency across young and older adult age groups for the categories of events reported (see supplemental materials), the motivational goals for the valence ratings provided by each (e.g., "met new friends" vs. "reinforced old friendships") may well differ across age groups.

Beyond the mental time travel task, results from the future excitement and worry ratings task also fail to follow the pattern predicted by the age-related positivity effect. In the context of excitement for the future, young adults were more excited (i.e., more positive) than middle-aged adults for 1 year into the future and were more excited than both middle-aged and older adults for 5–10 years into the future. Likewise, young adults were more worried (i.e., more negative) than middle-aged adults for 1 year into the future and were more worried than both middle-aged and older adults for 5–10 years into the future. Older adults' more muted responses—in both excitement and worry—may indicate the use of their well-developed emotion regulation skills associated with their more limited time horizons (Carstensen et al., 2020; Charles & Carstensen, 2014; Charles et al., 2003). These patterns offer interesting avenues for future work regarding the age-related changes in emotion regulation when thinking about the future during typical as well as unusual circumstances.

Limitations and Future Directions

There are a number of limitations to acknowledge in the present study, as well as important open questions and future directions suggested by our findings.

First, our sample contained a smaller number of older adults compared to the other age groups. Data collection necessarily took place online to maintain participant safety during the pandemic, and older adults are more difficult to recruit for online research studies. Online research participants tend to be younger (Levay et al., 2016), and older adults' interest in participating in research may be motivated by curiosity that is not satisfied by online research (Ryan & Campbell, 2021). Preoccupation with managing the significant health threat of COVID-19 to older adults (Center for Disease Control and Prevention, 2021) may have further precluded older adults' participation. Nonetheless, future studies should aim to include a larger older adult sample.

Although we collected a relatively large sample of 434 participants overall, as just noted, the distribution of participants throughout age groups was unequal, with fewer older adults compared to middle-aged and young adults. As such, it is unclear whether the age-related positivity effect disappeared in the personal domain due to the size of our older adult sample or if the COVID-19 pandemic serves as a boundary condition for the age-related positivity effect for personal past and future events. Furthermore, existing work on the age-related positivity effect has emerged largely in the context of the personal past (Kennedy et al., 2004; Schryer & Ross, 2014), with more variability in patterns for the personal future (e.g., Durbin et al., 2019; Lapp & Spaniol, 2017), but our findings emerged in the personal domain collapsed across the past and future; this difference may be the source of these differing patterns. While this point cannot be adjudicated in our data, it identifies the need for future tests targeted toward this question.

Further, although approximately 40% of our sample reported holding underrepresented racial/ethnic identities, our sample did not lend itself to exploration of the effects of the pandemic on racial/ethnic minorities (Tai et al., 2021) due to the uneven distribution of minority representation across age groups and racial/ethnic categories. Our study was not designed to characterize the valence of mental time travel across racial/ethnic lines, and a relative lack of diversity in our older adult sample precluded a sufficiently powered exploration of this variable. Although we observed no significant effect of race nor an age by race interaction in the mental time travel task for our analysis of young and middle-aged adults (see supplemental materials), it is possible that the relative lack of diversity in our older adult group may have contributed to age-related patterns observed here. Future research designed specifically to address this possibility is needed.

Moving beyond issues related to sample, our use of the future excitement and worry task followed prior work using this task to probe future-oriented excitement and worry (MacLeod & Byrne, 1996; MacLeod et al., 1997; Shrikanth et al., 2018) with slightly different configurations. As such, we did not probe excitement or worry for the past as we did for the future. Follow-up work may consider probing excitement and worry for the past in addition to the future.

Finally, an important question for future research is how best to characterize age for each of these valence-based phenomena. We characterized age as a grouping variable, following the tradition of past research on similar questions (e.g., Fung & Carstensen, 2006). Furthermore, given that past research in middle-aged adult samples is sparse (Lachman, 2015), it is unclear whether models should include linear or nonlinear age-related functions. As more work on age-related patterns in our key phenomena of interest emerges, researchers may consider modeling age as a continuous variable.

Conclusion

The present study is among the first to examine age comparisons in the collective negativity bias and the future-oriented positivity bias. In addition, we examined whether the age-related positivity effect extended to personal and collective mental time travel during the COVID-19 pandemic. Overall, we observed the collective negativity bias and the future-oriented positivity bias for collective events, even under the extreme context of COVID-19. We also found that these phenomena extend to the lesser studied period of middle age, suggesting that these effects are robust and may be expected to emerge across adult age groups regardless of context. Further, we observed extensions of the age-related positivity effect to collective future thinking, perhaps due to older adults' shift of attention from personal to collective matters. At the same time, we observed a surprising amount of positivity in young adults' personal mental time travel that was comparable to the personal positivity exhibited by older adults. This pattern diverges from what would be predicted by extensions of the age-related positivity effect that has mainly been observed for memories of the personal past. Our observed pattern of results may reflect COVID-related threats shortening future time horizons for both age groups, perhaps leading young adults to exhibit more positivity than is typical under the standard conditions of life. In this context, middle-aged adults were

the least positive, perhaps due to the exacerbation of personal pressures faced by those in the "sandwich generation" during the pandemic. Finally, we observed more muted ratings for both future excitement and worry in older cohorts at longer time horizons compared to young adults, which may reflect older-aged adults' more effective emotion regulation skill. Overall, our findings provide a basis for future exploration of these phenomena following a return to more typical times to clarify the extent to which these age-related patterns reflect the unusual and intense lived experiences during the pandemic and the extent to which they represent enduring differences in the valence of mental time travel.

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