

**Episodic memory and personal semantics as triggers of nostalgia:
its relationships between abstraction of memory content and temporal
distance**

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Supplemental data for this article can be accessed online at

<https://doi.org/10.1080/09658211.2023.2196038>.

This is an Accepted Manuscript of an article published by Taylor & Francis in Memory on 31 March 2023, available online: <http://www.tandfonline.com/doi/10.1080/09658211.2023.2196038>

Abstract: Nostalgia, an autobiographically relevant positive emotion, is a sentimental longing or wistful affection for the past. Autobiographical memory, which is one of the cognitive bases of nostalgia, includes both abstract semantic and detailed episodic memories. Recent studies have defined and classified memories that are located between semantic and episodic memory as personal semantics. Although autobiographical memory and personal semantics range over a continuum, past nostalgia research has not focused on or controlled them. In two experiments, undergraduate students retrieved episodic memory and personal semantics and rated cognitive and affective items. The intensity of nostalgia differed according to the types of memory content and temporal distance of the memory from the present. These results revealed that not only unique events but also repeated events and autobiographical facts induced nostalgia; furthermore, repeated events from both the distant and recent past (primary and high school, respectively) consistently induced relatively greater nostalgia, but in some cases, they were not significantly different from other types of memory (i.e., unique events and autobiographical facts). These findings suggest that both episodic memory and personal semantics are involved in the occurrence of nostalgia.

Keywords: nostalgia; autobiographical memory; episodic memory; personal semantics

Introduction

Nostalgia has been defined as “a sentimental longing or wistful affection for the past, typically for a period or place with happy personal associations” in an English dictionary (New Oxford Dictionary of English, 1998, p.1266). Nostalgia has also been defined as “Remembering the past favourably and the degree to which it is favourable” in a Japanese dictionary (nostalgia (*natsukashisa*); Shogakukan Unabridged Dictionary of the Japanese Language, 2007). Over two decades, many studies have investigated the emotional profiles, psychological benefits, and possible clinical applications of nostalgia. Cultural comparison studies have also examined whether nostalgia is a cross-cultural emotion. Hepper et al. (2014) investigated pancultural nostalgia in 18 countries. They found greater than moderate correlations for 35 features (Japan: $\rho = .77$), except for some countries in Africa. Hepper et al. (2014) found three factors that explained nostalgia prototypes for 15 countries (again, excepting African countries): (i) “longing for the past,” which included both cognitive (e.g., remembering and reminiscence) and emotional features (e.g., reliving/dwelling and missing/loss); (ii) “negative affect,” which included negative features (e.g., sadness/depression and pain/anxiety), and (iii) “positive affect,” which included general (e.g., feeling/emotion) and positive (e.g., comfort/warmth) features. Of these factors, the present study focuses on aspects of “longing for the past.”

The factor “longing for the past” included memory-relevant features, such as memory/memories, the past, and fond memories (Hepper et al., 2014, Table 4). In actuality, many studies have applied memory-driven procedures to induce nostalgia; for example, Wildschut et al. (2006) used autobiographical narratives, and Barrett et al. (2010) used autobiographical memory derived from familiar music. The remembered content induced by these procedures was mainly experienced past events and relationships with others (e.g., Wildschut et al., 2006); thus these can be interpreted as autobiographical memory (Evans et al., 2021). Based on these findings, the present study defines nostalgia as an emotion with the retrieval of autobiographical memory.

Autobiographical memory and nostalgia

When people retrieve autobiographical memory, they sometimes retrieve detailed episodic memories and sometimes abstract knowledge and concepts. These phenomena originate from the hierarchical structure of autobiographical memory, which facilitates retrieval on different levels, depending on goals (Conway, 2005; Conway & Pleydell-Pearce, 2000). If it is assumed that retrieval and recollection of autobiographical memory induce nostalgia, then memories that support the induction of nostalgia should range on a continuum from abstract concepts to episodic memory.

Various versions of the Event Reflection Task (ERT; Sedikides et al., 2015a), a procedure based on autobiographical events, have been used to induce nostalgia. Most of these tasks have

followed a common procedure of asking participants to reflect on their most nostalgic events (e.g., Wildschut et al., 2006). After participants wrote what they remembered of nostalgic episodes or ordinary episodes, their nostalgic narratives were found to contain both abstract words (e.g., adjectives) and concrete words (e.g., descriptive action verbs; Stephan et al., 2012). Based on the demands of the ERT task, participants might tend to recollect and describe the events that they could remember in detail. Alternatively, the only memory that they could remember in detail would be the target of the description. Thus, it can be expected that the ERT procedure is a task that facilitates the retrieval of episodic memory. However, this is unclear because no studies have analysed the content of memory retrieval.

Nostalgia can also be induced by melodies (Barrett et al., 2010), song lyrics (Routledge et al., 2011), scents (Reid et al., 2015), and photographs (Oba et al., 2016). In these stimulus-driven procedures, participants sometimes access highly abstract memory and other times specific memory; however, these studies have not analysed the retrieved contents. Although past studies have suggested a broad continuum of memory related to the induction of nostalgia, little has been reported on the relationship between memory specificity or abstractness and the arousal and intensity of nostalgia.

Evans et al. (2021) proposed that the simple recall of events in detail is not enough to evoke nostalgic experiences, because a feeling of reliving (mental time travel) is a central feature of nostalgia (Hepper et al., 2012). Mental time travel is one of the cognitive features of episodic memory (Wheeler et al., 1997). However, studies of stimulus-driven nostalgia have

successfully induced nostalgia although they did not explicitly measure or implicate the involvement of mental time travel and the recollection of episodic memories (Barrett et al., 2010; Barrett & Janata, 2016; Oba et al., 2016; Reid et al., 2015). Such stimulus-driven studies suggest that individuals can experience nostalgia without mental time travel and recall of episodic memory. It is also possible that nostalgia derived from stimulus-driven versus memory-driven procedures may differ in emotional intensity. Thus, the present study focuses on memory-driven procedures.

Personal semantics

Personal semantics (for a review, see Renoult et al., 2012) is a memory classification that has improved on the episodic-semantic dichotomy by including a continuum of four types of personal declarative memory that are located between episodic and semantic memory. These memories are autobiographically significant concepts, repeated events, autobiographical facts, and self-knowledge (Renoult et al., 2012).

Autobiographically significant concepts (e.g., This flower is a cherry blossom; I ate cherry blossom jam for the first time in primary school when I was in third grade and it was tasty) include important facts and related episodes (Renoult et al., 2012; Westmacott & Moscovitch, 2001, 2003). Repeated events (e.g., I rode a bicycle with my sister every day) include repeatedly experienced events (e.g., summarized/general events; Barsalou, 1988) with spatiotemporal contexts (Renoult et al., 2012). Autobiographical facts include personal semantic information

(Brewer, 1986; Renoult et al., 2012). Renoult et al. (2012) pointed out that contents reported in the Autobiographical Memory Interview (Kopelman et al., 1989) corresponded to autobiographical facts (i.e., school names, friend/teacher names, and living places). Self-knowledge, which is a summary of self-image, includes personality-relevant information (Brewer, 1986; Neisser, 1988; Klein & Lax, 2010; Renoult et al., 2012). Neisser (1988) proposed that social roles are part of the conceptual self, which is a kind of self-knowledge.

Personal semantics is not the only model distinguishing personal episodic and semantic memory. Similar perspectives have been expressed in the model of autobiographical memory of Martinelli et al. (2013) and the experience-near/far model of Grilli and Verfaellie (2014, 2016). Martinelli et al. (2013) identified three types of systems of declarative self: (i) episodic autobiographical memory (EAM), which is episodic memory with unique contexts for individuals' lives; (ii) semantic autobiographical memory (SAM), which is semantic memory for personal events such as extended and repeated events, and for personal information comprising of autobiographical facts, faces of familiar or famous people, familiar places, and familiar names; and (iii) conceptual self (CS), which contains conceptual semantic information about the self, such as beliefs and personality. In this model, a section of SAM corresponds to the repeated events and autobiographical facts of Renoult et al. (2012), and likewise part of CS corresponds to the self-knowledge of Renoult et al. (2012). The models of Martinelli et al. (2013) and Renoult et al. (2012) are similar in that both depict the declarative aspects of self-representation, and they differ in that the framework of Martinelli et al. (2013) has a perspective

on autobiographical memory, while Renoult et al. (2012) has a perspective on episodic-semantic memory.

In line with previous studies (Conway & Pleydell-Pearce, 2000; Martinelli et al., 2013), Grilli and Verfaellie (2014) proposed to differentiate autobiographical facts in terms of whether they are related to spatio-temporal and perceptual details. They suggested that the contribution of the medial temporal lobe (MTL) during retrieval might differ depending on how far autobiographical facts are from unique experiences. Grilli and Verfaellie (2016) proposed the following classification of autobiographical facts based on the proposal by Grilli and Verfaellie (2014); experience-near content includes lifetime period derived facts (e.g., I lived in Tokyo when I was a child), repeated event derived facts (e.g., I play soccer every Saturday), and unique event derived facts (e.g., I went to the flea market and bought a flower vase last Saturday). Experience-far content does not have spatiotemporal context (e.g., I have a son and a daughter; Grilli & Verfaellie, 2016). The repeated events and autobiographically-significant concepts of the model of Renoult et al. (2012) may be similar to experience-near content, and self-knowledge may be similar to experience-far content. Autobiographical facts differ from repeated events, autobiographically-significant concepts, and self-knowledge, some of which are experience-near content, and otherwise are experience-far content (Grilli & Verfaellie, 2016; Renoult et al., 2020).

In comparisons of personal semantics subtypes in terms of the episodic-semantic distinction, autobiographically significant concepts and repeated events are similar to episodic

memory, autobiographical facts are similar to semantic memory, and self-knowledge is dissimilar to both (Renoult et al., 2012; Renoult et al., 2016). Unique events, or single incidents with spatiotemporal context (equivalent to episodic memory; Renoult et al., 2012), repeated events, autobiographical facts, and self-knowledge are targets of the present study.

Autobiographically significant concepts were excluded from the present study for two reasons.

Firstly, most previous studies of personal semantics have not directly compared autobiographically significant concepts, other personal semantics subtypes, and episodic memory (e.g., Renoult et al., 2016; Tanguay et al., 2018). Secondly, autobiographically significant concepts, such as combinations of semantic knowledge and vivid episodes, were inappropriate because the present study aimed to manipulate the specificity/abstractness of a single memory as a trigger of nostalgia.

The types of memories that induce nostalgia remain unclear, because no previous studies have adopted a personal semantics framework to identify nostalgia triggers. The following section presents the rationale for the stance that repeated events, autobiographical facts, and self-knowledge are each related to nostalgia.

Personal semantics and nostalgia

Kusumi et al. (2010) analysed descriptions of nostalgic events with cluster analysis and found that effective event-related triggers of nostalgia were visiting old schools and friends, remembering school days, and looking at children in a park (e.g., primary school, junior high

school, high school, sports festivals, children). They also found that media-related nostalgia triggers included visual information, such as monochrome colours, and music repeatedly listened to in the past. Based on these findings, Kusumi et al. (2010) argued that frequent repetition of a nostalgic object and a long-time lag from the present are important for generating nostalgia. They considered that this model was related to the mere exposure effect (Zajonc, 1968). Zizak and Reber (2004) discussed that repeated exposure to sentimental items might be associated with positive emotions and familiarity, which form emotional memories and comfort related to those items that help elicit nostalgia. Additionally, intensity of nostalgia was significantly predicted by familiarity towards stimuli (e.g., Barrett et al., 2010; Reid et al., 2015). Therefore, the present study predicted that memories referring to repeated events are involved in the occurrence of nostalgia.

Nostalgia supports the access of self-concepts (e.g., Vess et al., 2012). Grilli and Verfaellie (2015) investigated the network of personal semantic memory that supports the self. They found that memories associated with defining participants' personality traits were most often personal semantic memories, such as traits/roles, beliefs, and autobiographical facts. In short, these personal semantic memories are frequently referred to in defining the self. This result suggests that abstract memories are highly available as resource for defining the self; that is, episodic memories are not always dominant. In addition, Grilli (2017) found that memories associated with defining oneself ten years ago included more experience-far personal semantic memory, but those associated with oneself one year ago included more experience-near personal semantic

memory, which is similar to episodic memory, such as facts derived from unique events, repeated events, and lifetime periods (Grilli, 2017). This indicates that memories supporting the self are not always detailed and that memories may be abstracted and used over time. Based on these findings, the present study explored whether memories with higher levels of abstraction (self-knowledge, autobiographical facts) would be involved in the occurrence of nostalgia, a self-relevant emotion.

Temporal distance and self-discontinuity

It has been theorized that nostalgia arises in transition, due to subjective discontinuity in the desire for continuity between the past and present (Davis, 1979). Consistent with this proposal, Kusumi et al. (2010) demonstrated that TV advertisements and music with a long-time lag tended to be evaluated as being nostalgic. Stephan et al. (2012) showed that nostalgic events were more temporally and spatially distant than ordinary events, but there was no significant difference between nostalgic and positive events. Similarly, events that participants felt as if happened recently made them feel more nostalgic than the events that they felt as if they had happened a long time ago (van Tilburg et al., 2019).

When we consider that temporal distance as the factor which enhances nostalgia, it is unclear whether nostalgia is further enhanced by increasing temporal distance. According to Davis's (1979) theory however, temporal distance and nostalgia probably do not have a simple linear relationship. It might be essential that the temporal distance is sufficiently far apart to give a sense

of discontinuity. Thus, the present study established and manipulated three types of temporal distances.

Overview, hypothesis, and prediction

The present study investigated the relationships between memory specificity/abstractness of autobiographical memory, temporal distance, and the intensity of nostalgia, with a focus on the personal semantics framework. In Experiment 1, participants reported their episodic memories and events or facts derived from personal semantics on the first day. After a one-week interval, on the second day, participants rated the intensity of nostalgia when they remembered memories by looking at stimulus sentences that an experimenter reconstructed from the descriptions of the first day. We hypothesized that the intensity of nostalgia would differ depending on remembered memory content, and that repeated events would produce a higher intensity of nostalgia than other types of memory content (unique events, autobiographical facts, and self-knowledge), because the model of nostalgia evocation proposes that repetition is an important factor in nostalgia (Kusumi et al., 2010). Furthermore, we explored whether the intensity of nostalgia differed for each temporal distance of memory. In Experiment 2, the procedure was modified so that memory retrieval and rating were performed without an interval. Based on the results of Experiment 1, we examined the effects of memory contents and temporal distance, and whether there was an interaction effect between the two factors. Each memory might be involved in the arousal of nostalgia, therefore, we examined the intensity

differences among the other memories (i.e., unique events, autobiographical facts, and self-knowledge) in an exploratory manner in Experiments 1 and 2.

Experiment 1: materials & methods

Design

Experiment 1 employed a two-factor, within-participant design. Independent variables were memory content (4 levels: unique events, repeated events, autobiographical facts, and self-knowledge) and temporal distance (3 levels: primary school grades 1-3, secondary or high school grades 10-12¹, one month ago). The dependent variable was the intensity of nostalgia (ratings on a scale of 1-7).

Participants

Thirty-five Japanese undergraduate students participated². Data from one participant were excluded from the analysis because of a technical problem. Thus, the final number of participants was 34 ($M = 20.8$, $SD = 0.9$, male = 12). Because the number of lifetime periods varies depending on educational background, work experience, and age, Japanese university students, who tend to have a uniform educational background, were recruited. Each received an

¹ In Japan, students attend primary school for six years (grades 1-6), junior high school for three years (grades 7-9) and high school for three years (grades 10-12). The data were collected with reference to the first half of primary school (grades 1-3) and all of high school (grades 10-12).

² Sample size was determined based on the result of G*Power (Faul et al., 2007, 2009). Assuming a one-way analysis of variance (with four levels) to examine the main effect of contents of memory, with effect size $f = 0.25$, $\alpha = .05$, and power = .90, the number of participants required for the pre-test was calculated to be 30.

Amazon gift card with a value of 1000 JPY as a reward for participation. The Ethical Review Board for Experimental Psychology Research of the Graduate School of Education at Kyoto University approved both Experiments 1 and 2.

Procedure

This experiment was conducted on two days separated by a one-week interval. On day 1, participants reported their memories of events, facts, and personalities on a Google Form (see Day 1 - description task). Day 2 took place one week after day 1 (see Day 2 - experimental task). jsPsych ver. 6.1.0 (de Leeuw, 2015) was used for the presentation of instructions, stimuli, and rating materials. Participants accessed the URL for the experiment from their homes using their PCs. They were instructed to remember and mentally picture events or facts when a stimulus sentence was presented on the screen. Subsequently, they were instructed to rate using 3- or 7-point Likert scales what they felt when a stimulus was presented (see Rating task). After two practice trials in which sample stimulus sentences were presented, the experimental task was performed. A fixation cross was presented in the centre of participants' screens for 1000 ms, and then a stimulus sentence was presented for 7000 ms. One trial was considered as the set of events from the stimulus presentation to the rating task. After all 24 trials were completed, questionnaires were administered with using Google Forms (see **Questionnaire survey**).

Day 1 - description task

Participants remembered and wrote events or facts in six categories: (a) Social role (as a subtype of self-knowledge; Neisser, 1988), (b) Personality traits representing themselves at that

time (as a subtype of self-knowledge; Renoult et al., 2012), (c) Nicknames of close friends (as a subtype of autobiographical fact; Kopelman et al., 1989; Renoult et al., 2012) , (d) Frequency and content of habits (as a subtype of autobiographical fact; Renoult et al., 2016) , (e) Time, place, and content of a single positive or neutral event (as unique events; Renoult et al., 2016) , and (f) Time, frequency, place, and content of repeatedly occurring positive or neutral events (as repeated events; Renoult et al., 2016). For (a) to (d), participants were asked to provide one response for each of three temporal distances: for grades 1-3 (primary school condition), for grades 10-12 (high school condition), and for one month ago (one month condition). For (e) and (f), participants were asked to describe two school-related events each for grades 1-3 and grades 10-12, and two events that occurred at home one month ago. Participants were asked to limit the valence of recalled events to positive or neutral in order to avoid recall of painful events. Only category (b) used a multiple-choice response format, based on Hayashi and Horiuchi (1997).

Day 2 - experimental task

Stimulus sentences were created by the experimenter based on day 1 answers. The content of these sentences differed for each participant, because the content of autobiographical memory and the intensity of nostalgia were intended to correspond. The sentence structure was determined with reference to Renoult et al. (2016). The category of stimulus sentences corresponded to the day 1 description task: Unique events (e.g., In December of the year I was in grade 2, a neighbouring classmate fell down while performing a traditional dance as part of a sports festival on the primary school playground), repeated events (e.g., When I was a freshman

in secondary school (high school), I practiced singing six times a week in the music room), autobiographical facts/friends (e.g., Mr. A was my good friend from a month ago to the present), autobiographical facts/habits (When I was in the second year of high school, I drank milk six times a week), self-knowledge/personality (e.g., I am an outgoing person from a month ago to the present), self-knowledge/social role (e.g., When I was a sophomore in high school, I was a rabbit keeper). These categories formed the experimental conditions. Friends and habits were averaged and treated as the autobiographical condition, and personality and social roles were similarly treated as the self-knowledge condition. The statement “I was a primary school student 12 years ago” was substituted as a general statement when the statements “I was a primary school student” or “I do not remember/Nothing in particular” were obtained during the Day 1’s description task, after confirming that the relevant participant was indeed a primary school student 12 years ago, based on his/her age at the time of the experiment.

Rating task

Participants rated ten items with reference to the situation at the time the stimulus sentence was presented: (i) comfort (1: *Very uncomfortable*, 7: *Very comfortable*), (ii) arousal (1: *Not aroused at all*, 7: *Very aroused*), (iii) nostalgia (1: *I do not feel nostalgia at all*, 7: *I feel nostalgia very strongly*) (iv) happiness (1: *I do not feel happy at all*, 7: *I feel very happy*), (v) sentimentality (1: *I am not sentimental at all*, 7: *I am very sentimental*), (vi) frequency of recollection (1: *I rarely remember or think about it*, 2: *Once or twice in five years*, 3: *Once or twice in three years*, 4: *Once or twice a year*, 5: *Three or four times a year*, 6: *Once a month*, 7:

More than once a week), (vii) subjective distance (1: *I feel very close to it*, 7: *I feel very distant from it*), (viii) importance (1: *Not important at all*, 7: *Very important*), (ix) vividness of imagery (1: *Not vivid at all*, 7: *Very vivid*), and (x) perspective (1: *First-person perspective*, 2: *Neither*, 3: *Third-person perspective*). The definition of perspective was based on Nigro and Neisser (1983), and the experimenter instructed participants that a first-person perspective meant that they were looking at the events/facts from their own perspective at the time, while a third-person perspective meant that they were looking at the events/facts from an observer's perspective (behind, in front of, above, etc.). Rating items (i)-(v), (vii)-(ix) were selected and developed with reference to nostalgia-related studies (Barrett et al., 2010; Hepper et al., 2012, 2014; Oba et al., 2016; Stephan et al., 2012; Wildschut et al., 2006). Items (vi) were selected and developed with reference to an autobiographical memory study (Rathbone et al., 2015).

Questionnaire survey

To measure participants' trait nostalgia, they completed the Positive-Negative Nostalgia Proneness Scale³ (PN-NP; nostalgia proneness - positive: NP-P; nostalgia proneness - negative: NP-N; nostalgia proneness - reminiscence: NP-R; Kusumi, 2021) and seven items from the Japanese version of the Southampton Nostalgia Scale⁴ (SNS; Barrett et al., 2010; Kusumi, 2021; Routledge et al., 2008). For exploratory research, empathy, which is related to trait

³ Kusumi (2021) has developed an 18-item structure of this scale. However, we used the original 22-item version.

⁴ When collecting SNS responses, the experimenter mistakenly typed "Three to four *days* a week", even though the correct choice was "Three to four *times* a week". Second, it was mistakenly stated as "Approximately two *days* a week", even though the correct choice was "Approximately two *times* a week". This error was corrected in Experiment 2.

nostalgia (e.g., Juhl et al., 2020), was measured using the Japanese version of the Interpersonal Reactivity Index (IRI; Davis, 1980; Himichi et al., 2017). Subsequently, participants were asked to indicate their levels of satisfaction with themselves at the three past temporal distances and the present time (1: *Not satisfied at all*, 7: *Very satisfied*) as well as the environmental changes and other important changes between the three past periods and the present time (1: *Changed*, 2: *Not changed*). These items were intended to evaluate the discontinuity hypothesis that nostalgia occurs with a discontinuity of past and present that derives from present anxiety and fears (Davis, 1979).

Reliability

Cronbach's alpha was .91 for SNS, ranged from .81 to .90 for PN-NP, and ranged from .56 to .83 for IRI. These analyses were conducted the *ltm* package (v.1.1.1; Rizopoulos, 2006) in R (v.4.1.1; R Core Team, 2021).

Experiment 1: results

In the Day 1 description task in the primary school condition, participants were asked to describe events and facts from grades 1-3, but in 13 cases (7 students), they were unable to remember these and provided events from grades 4-6 instead. Thus, these data were excluded from the analysis (remaining data: 803 cases). The means and standard deviations of nostalgia ratings for each condition are shown in Figure 1.

Memory contents with higher intensity of nostalgia

A one-way ANOVA was performed on nostalgia ratings for the types of memory content (unique events, repeated events, autobiographical facts, and self-knowledge). All ANOVA in the present study were conducted using the *anovakun* function (Iseki, 2021) and the *effsize* package (v.0.8.1; Torchiano, 2020). The main effect of memory content was significant ($F(2.91, 95.88) = 21.17, MSE = 0.32, p < .001, \eta^2_G = .24$)⁵. Multiple comparisons⁶ showed that nostalgia ratings were significantly higher for unique events, repeated events, and autobiographical facts than for self-knowledge ($ts(33) = 7.15, 5.85, 5.03; ps < .001$; Hedges' $gs = 1.42, 1.20, 1.02$). There was no difference in the remaining pairs.

Subsequently, we conducted an additional two-way ANOVA for the types of memory content and temporal distance (primary school, high school, and one month ago) to consider the effects of temporal distance and the interaction between the two factors. This procedure enabled us to test whether repeated events produced a higher intensity of nostalgia than other types of memory content for each temporal distance level. Data for three participants who could not retrieve any events in the primary school condition were excluded from this analysis because the numbers at each level should be equally matched (participant-wise deletion; $N = 31$; the remaining 738 data points were summarized to 372 data points for the repeated ANOVA). The main effect of memory content was significant ($F(2.82, 84.7) = 23.76, MSE = 0.94, p < .001$,

⁵ Greenhouse-Geisser correction was used to adjust the degrees of freedom for F statistic in repeated measures. This correction was applied to all ANOVA in this study.

⁶ p values were adjusted with Holm's method. This adjustment was applied to all post-hoc t -tests in ANOVA in this study.

$\eta^2_G = .14$). Multiple comparisons showed that nostalgia ratings for unique events, repeated events, and autobiographical facts were higher than for self-knowledge ($ts(30) = 7.58, 5.86, 4.63$; $ps < .001$; Hedges' $gs = 1.63, 1.31, 1.02$). Unique events received significantly higher nostalgia ratings than autobiographical facts ($t(30) = 3.73, p = .002$, Hedges' $g = 0.67$). There was no significant difference between unique and repeated events or between repeated events and autobiographical facts ($ts(30) = 1.87, 1.49$; $ps = .142, .147$; Hedges' $gs = 0.37, 0.31$). The main effect of temporal distance was also significant ($F(1.78, 53.32) = 172.71, MSE = 2.23, p < .001, \eta^2_G = .63$). Multiple comparisons revealed that nostalgia ratings were higher for events from both primary and high school than for those from one month ago ($ts(30) = 14.04, 15.67$; $ps < .001$; Hedges' $gs = 3.60, 4.32$), and the primary and high school ratings did not differ significantly ($t(30) = 1.26, p = .218$, Hedges' $g = -0.26$). Given the significant interaction of memory content and temporal distance ($F(4.82, 144.74) = 10.39, MSE = 0.94, p < .001, \eta^2_G = .11$), a simple effects test for memory content revealed a significant main effect at each temporal distance (primary school, high school, one month ago: $F_s = 18.11, 6.10, 20.08$; $MSEs = 0.96, 0.72, 0.98$; $ps < .001$; $\eta^2_{Gs} = .23, .10, .27$). Multiple comparisons for the primary school data showed significantly higher nostalgia ratings for unique events, repeated events, and autobiographical facts than for self-knowledge ($ts(30) = 3.69, 5.34, 6.25$; $ps < .01$; Hedges' $gs = 0.70, 1.20, 1.24$). Unique events were lower in nostalgia than repeated events and autobiographical facts ($ts(30) = 2.57, 3.02$; $ps < .05$; Hedges' $gs = -0.53, -0.55$). These results indicate that participants remembered repeated events and autobiographical facts with a high

intensity of nostalgia in the primary school condition. Multiple comparisons for the high school data revealed significantly higher nostalgia ratings for unique events than for autobiographical facts and self-knowledge ($t(30) = 3.24, 3.41; ps < .05$; Hedges' $gs = 0.71, 0.76$), and for repeated events than for self-knowledge ($t(30) = 2.91, p = .027$, Hedges' $g = 0.58$). Ratings of unique events and repeated events did not differ significantly ($t(30) = 0.42, p = 1.000$, Hedges' $g = 0.08$).

These results indicate that participants remembered unique and repeated events with a high intensity of nostalgia in the high school condition. In the one month condition, multiple comparisons revealed that unique events were rated significantly higher than repeated events, autobiographical facts, and self-knowledge ($ts(30) = 4.96, 5.27, 6.10; p < .001$; Hedges' $gs = 1.02, 1.06, 1.49$); however, mean nostalgia ratings for all events were below the mid-point (one sample t-test; unique events, repeated events, autobiographical facts, self-knowledge, respectively, $ts(30) = -2.16, -9.62, -9.97, -13.21; ps < .05$; Hedges' $gs = -0.38, -1.68, -1.74, -2.31$). It cannot be concluded that nostalgia has arisen from the fact that nostalgia ratings at or below the mid-point (i.e. 1: *I do not feel nostalgia at all*, 2: *I do not feel nostalgia*, 3: *I somewhat do not feel nostalgia*, and 4: *Neither-I cannot say whether or not I feel nostalgic*). Thus, there was no memory content which induced higher nostalgia in the one month condition.

[Insert Figure 1 here]

Experiment 1: discussion

The results of the one-way ANOVA showed a significant main effect of memory contents. Multiple comparisons indicated that the nostalgia intensity was higher when participants remembered repeated events than self-knowledge. However, there were no differences between repeated events and unique events, repeated events and autobiographical facts. Therefore, the Experiment 1's results partially support the hypothesis that the intensity of nostalgia would differ depending on remembered memory content and that repeated events would produce a higher intensity of nostalgia than other types of memory content. An exploratory performed two-way ANOVA showed that repeated events and autobiographical facts evoked higher intensity of nostalgia in the primary school condition, and unique and repeated events evoked higher nostalgia intensity in the high school condition. Therefore, analysing the interaction between types of memory content and temporal distance revealed different tendencies from the one-way ANOVA. Nevertheless, remembering repeated events did not evoke the greatest nostalgia.

In the model of Renault et al. (2012), the abstractness of the memory content of personal semantics changes in which abstractness is lowest for repeated events, moderately abstract for autobiographical facts, and the most abstract for self-knowledge. Unique events are less abstracted than repeated events because unique events are captured in episodic memory. This continuum of abstraction of episodic and personal semantics was not directly related to the high

or low intensity of nostalgia in Experiment 1. Instead, the result that repeated events and autobiographical facts were accompanied by a high intensity of nostalgia in the primary school condition, and unique and repeated events were accompanied by a high intensity of nostalgia in the high school condition, suggests that the influence of memory abstraction on the intensity of evoked nostalgia depends on the temporal distance from the present. This possibility is relevant to the results of Grilli (2017), in which the strength of association between subtypes of personal semantics and self-representation of identity differed corresponding to the temporal distance of the acquisition or formation of semantic knowledge. Grilli's study and the results of Experiment 1 imply that autobiographical facts, such as habits and knowledge of friends, may support the remotely formed self (the self of ten years ago), and this relationship can be interpreted as the types of memory content that supports a high intensity of nostalgia. However, it should be noted that this does not explain the low intensity of nostalgia associated with the retrieval of self-knowledge.

Effects of temporal distance on the intensity of nostalgia

The exploratory comparison of nostalgia ratings at the three temporal distances demonstrated that nostalgia was lower in the one month condition than in the primary and high school conditions (Figure 1). At the same time, there were no significant differences between the primary school and high school conditions. Thus, the results partially support the proposals that a long time lag triggers nostalgia (Kusumi et al., 2010) and that nostalgic events have a

greater temporal distance than non-nostalgic events (Stephan et al., 2012). If the relationship between distance in time and intensity of nostalgia is linear, nostalgia should be higher in the primary school condition than in the high school condition. However, such a result was not obtained. One possible reason is the difficulty of memory retrieval. Missing data in the primary school condition and participants' reports reflected the difficulties of retrieval of unique events and social roles (e.g., school committees) in the early primary school years. By contrast, retrieval of events in the high school condition should have been relatively easy because of the large number of retrieval cues, such as school festivals and club activities. Because successful remembering is misattributed as a positive evaluation of memory content (Leboe & Ansons, 2006), it is possible that the difficulty of retrieval lowered nostalgia in the primary school condition, resulting in higher ratings in the high school condition for unique events. In order to confirm this, it would be necessary to present categories that do not involve difficulties in retrieval, such as having the participants report events from the upper grades as well as the lower grades of primary school.

Experiment 2

The exploratory analyses of Experiment 1 suggested a relationship between nostalgia, the abstractness of autobiographical memory, and temporal distance. However, we need to reconfirm this relationship using an additional study with a proper sample size to retest the

interaction between the types of memory content and temporal distance from the present.

Additionally, several methodological limitations remain to be addressed. First, the two sessions raised the possibility that the memory description task in Day 1 may have caused nostalgia, but nostalgia may have decreased by the time of the rating task on Day 2. Thus, we designed Experiment 2 to be completed in one day. Second, it is unclear whether the only the memory contents' description presented on the screen functioned as a trigger for nostalgia. Therefore, we observed whether involuntary memories associated with autobiographical memory remembered by cue words were reported for the trials. If the participants in Experiment 2 retrieved involuntary memories, they were asked to report and rate the associated nostalgia. A third possibility was an overlap between repeated events and autobiographical facts in the retrieved content. In Renoult et al. (2016), autobiographical facts were defined as habits that were usually performed behaviours, and repeated events were defined as behaviours that had been repeated within the past one year. Although it can be argued that the different temporal distances of the references ensure that there is a difference between the two, the stimuli in the present study that related to habits and repeated events were each presented at three temporal distances, thus possibly obscuring the difference defined by Renoult et al. (2016). Thus, in Experiment 2, school names were used as autobiographical facts instead of habits, with reference to Autobiographical Memory Interview examples (Kopelman et al., 1989). A fourth concern is that continuity from past to present may have functioned as a confounding factor. As mentioned in the Introduction, Experiment 1 controlled for the temporal distance because temporal distance

might be associated with self-discontinuity. In addition, participants were asked to report differences between time periods in terms of "environmental change" as a question⁷. However, those measures were insufficient to capture the actual (dis)continuity, and continuity would have been different for each memory. For example, some items may have been stable between the past and present; for instance, more than 70% of consistency in the trait ratings between present and five years ago is found for participants aged 18-49 years (Rutt & Löckenhoff, 2016, Figure 2). In addition, the perception of self-discontinuity between past and present enhances state-level nostalgia (Sedikides et al., 2015b). Thus we considered the presence or absence of continuity to be a confounding factor.

In addition to modifying the procedures, we also revised the hypothesis. In a comparison of nostalgia evoked by retrieval of unique events versus common events that happened repeatedly, van Tilburg et al. (2019) found that nostalgia was greater for unique events. However, the temporal distance may have worked as a confounding factor in their study because it was manipulated as a different dimension. Similarly, although Kusumi et al. (2010) proposed that repeated exposure to objects was crucial in enhancing nostalgia, they did not manipulate the types of memory content and temporal distance with simultaneous timing. Nostalgic events are more distant than that of ordinary events (Stephan et al., 2012). Moreover the types of autobiographical memories likely to be retrieved depend on temporal distances (Grilli, 2017). Therefore, it might be possible to evaluate the influence of memory content characteristics (i.e.,

⁷ This data is presented in supplemental material.

uniqueness or repetition) on the intensity of nostalgia by testing the interaction between temporal distance and memory content. Indeed, the interaction between memory content and temporal distance was significant in Experiment 1. As a result, we hypothesised that the effect of memory contents on the intensity of nostalgia would differ with the temporal distance from the present.

The aim of Experiment 2 was to address the four methodological issues above and to examine whether the interaction results obtained in Experiment 1 could be replicated. Based on the results of Experiment 1, we hypothesised that the types of memory content involved in evoking a greater intensity of nostalgia would differ with the temporal distance from the present. More specifically, we predicted the following results: In the primary school condition, which represents the remote past, repeated events and autobiographical facts would induce greater nostalgia than other types of memory content. In the high school condition, which represents the recent past, unique and repeated events would induce higher nostalgia than other types of memory content.

Experiment 2: materials & methods

Participants

Fifty-five Japanese undergraduate students participated (28 male, $M_{\text{age}} = 20.4$, $SD_{\text{age}} =$

0.9)⁸. Participants received an Amazon gift card with a value of 1200 yen as a reward for participation.

Procedure

This experiment, which lasted 50-70 minutes, was conducted individually and online. jsPsych ver. 6.1.0 (de Leeuw, 2015) was used for all procedures. Participants received an email that included the URL for the experiment and participated at a time of their choice. The experiment included three procedures. First, a memory description task and a rating task were conducted for 24 trials (see Memory description task and Rating task). Second, an associated (involuntary) memory description task and a rating task were conducted (see Associated memory description task). Third, a questionnaire survey was administered (see Questionnaire survey).

Memory description task

Participants were instructed to retrieve a memory that matched two cue words presented on the PC screen. Participants pressed the space key as soon as they retrieved the matching memory. After the screen switched, they typed and described the retrieved memory content. There were two types of cue words: temporal distance (primary school, high school, and one

⁸ The sample size was determined based on a PANGEA analysis (Westfall, 2016; <https://jakewestfall.shinyapps.io/pangea/>). The experiment used a two-factor (memory content, temporal distance) within-participant design, and the main focus of the analysis was to test the interaction. Thus, the fixed effects for which we wanted to calculate power were set as the interaction between the memory content factor [0.75, -0.25, -0.25, -0.25] and the temporal distance factor [0.666, -0.333, -0.333]. With a moderate effect size $d = .45$, two replicates, and variance partition coefficients $\text{var}(\text{error}) = .333$, $\text{var}(\text{participant} \times \text{factor 1} \times \text{factor 2}) = .083$ (initial value), the resulting power was .80 for 51 participants. Based on the possibility that the number of analysable data points may be reduced due to failure to follow the instructions and technical problems, 55 participants were recruited and were included in the analysis.

month ago) and memory content (unique event that occurred in school or at home (i.e., unique events), repeated events that occurred repeatedly in school or at home (i.e., repeated events), school name that they attended, name of close friends, personalities, social roles). Unique and repeated events were intended to retrieve positive or neutral content in Experiment 1, but this experiment did not set limits on emotional valence because of the risk that only positive nostalgia would be observed. For school names, the answer “I can/cannot retrieve the school name” was adequate. For friends, an answer that provided the initials was adequate. These two types of memory content were analysed as autobiographical facts. Personalities and social roles were the same as in Experiment 1, and they were analysed as self-knowledge. According to the types of memory content, there were sections that participants fill in their answers. When describing unique events, they filled in the blanks regarding the time, place, and content of events; when describing repeated events, they filled in the time, frequency, place, and content of events; and when describing autobiographical facts (school names and friends) and self-knowledge (personalities and social roles), they filled in the time and content. Each combination of temporal distance and unique/repeated events was presented twice, while the subtypes of autobiographical facts and self-knowledge were presented once for each temporal distance.

Rating task

There were eight rating variables. Participants rated these items with reference to the situation during retrieval. Item (i) assessed the presence or absence of an associated memory (Were any other memories retrieved spontaneously, using the events or facts you described as

cues? 1: *Yes*, 2: *No*). Rating items that were the same as those in Experiment 1 were as follows: (ii) comfort, (iii) nostalgia, (iv) frequency of recollection, (v) importance, (vi) sentimentality, and (vii) subjective distance. Questions about the continuity of (i) and (viii) were newly added to address issues raised by Experiment 1 (How long did the events or facts you described continue to persist? 1: *Not continuous, as it was a single event*, 2: *Continued until more than 10 years ago*, 3: *Continued until 8-9 years ago*, 4: *Continued until 6-7 years ago*, 5: *Continued until 4-5 years ago*, 6: *Continued until 2-3 years ago*, 7: *Continued until half a year-1 year ago*, 8: *Continued until 1-5 months ago*, 9: *Continued to the present*).

Associated memory description task

Participants described associated memory content derived from the first memory description task. As a cue, the description that participants had provided together with the associated memory was presented at the top of the screen. This procedure was designed with reference to Brown and Schopflocher (1998). After the description, the rating task was conducted in the same manner as the first memory description task. There were seven rating items: (ii)-(viii). One trial was defined as a cycle of the associated memory description task and the rating task. The average number of trials was 13.40 ($SD = 6.63$, min = 0, max = 24) because the number of involuntary memories differed depending on the individual.⁹

Questionnaire survey

Participants completed the Positive-Negative Nostalgia Proneness Scale (PN-NP; Kusumi,

⁹ Statistics were calculated based on all data ($N = 737$).

2021) and a 7-item Japanese version of the Southampton Nostalgia Scale (SNS; Barrett et al., 2010; Kusumi, 2021; Routledge et al., 2008). As in Experiment 1, participants also completed a questionnaire about their levels of satisfaction with themselves at the past three temporal distances and at the present time, as well as the environmental changes and other important changes between the three past points in time and the present time.

Data analytic strategy

In analyses of the responses according to the types of memory content, the mean of the two unique events and the mean of the two repeated events from the same temporal distance were treated as representative values respectively. The mean rating for school names and friends was treated as the representative value of autobiographical facts, and the mean rating for personalities and social roles for the same temporal distance was treated as the representative value of self-knowledge.

In analyses of the description data¹⁰, when the same memory was judged to have been described more than once, only the first response was included and the other responses were excluded. A total of 20 trials (1.5% of the total) were excluded. All 729 data points (i.e., data associated with 1300 valid responses) were included in calculations of the frequency of occurrence of the associative memories and in developing a model with the presence or absence of associations as an independent variable. In analyses of the ratings of the associative

¹⁰ There were 24 descriptions that differed slightly from the instructions in their specifications of place and time (e.g., writing about an event that happened a week ago when instructed to write about an event a month ago, or writing about an event at a building near the school when asked to retrieve an event that happened at school). However, these were included in the analysis.

memories, 15 cases in which the participants reported that they had forgotten the associative content and eight cases in which the associations were based on duplicate descriptions were excluded. A total of 23 data points (3.1% of the total) were excluded.

Reliability

Cronbach's alpha was .91 for SNS, ranged from .82 to .87 for NP-P, NP-N, and NP-R.

Experiment 2: results

Memory contents with higher intensity of nostalgia

A four (types of memory content: unique events, repeated events, autobiographical facts, and self-knowledge) \times three (temporal distance: primary school, high school, and one month ago) ANOVA was performed. The mean and *SD* of each condition is shown in Figure 2. The main effect of memory content was significant ($F(2.8, 151.25) = 21.86, MSE = 0.80, p < .001, \eta^2_G = .05$). Multiple comparisons showed that nostalgia intensity was significantly higher for unique events than for repeated events, autobiographical facts, and self-knowledge ($t(54) = 3.01, 4.74, 7.58; ps < .05; \text{Hedges' } gs = 0.26, 0.54, 0.80$); nostalgia intensity was significantly higher for repeated events than for autobiographical facts and self-knowledge ($t(54) = 2.68, 4.94; ps < .05; \text{Hedges' } gs = 0.29, 0.57$); and nostalgia intensity was significantly higher for autobiographical facts than for self-knowledge ($t(54) = 2.49, p = .020, \text{Hedges' } g = 0.31$). The main effect of temporal distance was also significant ($F(1.63, 87.86) = 248.60, MSE = 3.01, p < .001, \eta^2_G = .55$). Multiple comparisons revealed that the intensity of nostalgia was

significantly higher in the primary school and high school conditions than in the one month condition ($ts(54) = 16.44, 20.19; ps < .001$; Hedges' $gs = 3.01, 3.07$), but the primary and high school conditions did not differ significantly ($t(54) = 1.57, p = .123$, Hedges' $g = 0.18$). The interaction between memory content and temporal distance was significant ($F(5.22, 282.08) = 6.80, MSE = 0.93, p < .001, \eta^2_G = .03$). A simple main effect test of temporal distance at the level of each memory content was significant (with unique events, repeated events, autobiographical facts, and self-knowledge in ascending order; $F_s = 73.04, 166.92, 175.83, 106.85; MSEs = 1.33, 1.31, 1.18, 1.57; ps < .001, \eta^2_{GS} = .40, .61, .65, .51$); and the simple main effect test of memory content at each level of each temporal distance was also significant (with primary school, high school, and one month ago in ascending order; $F_s = 6.16, 10.98, 16.96, MSEs = 0.88, 0.71, 1.00; ps < .001; \eta^2_{GS} = .04, .07, .14$).

Based on these results, multiple comparisons of memory content were conducted on the intensity of nostalgia in the primary and high school conditions¹¹. In the primary school condition, nostalgia intensity was significantly higher for autobiographical facts than for self-knowledge ($t(54) = 3.69, p = .003$, Hedges' $g = 0.49$), and nostalgia intensity was significantly higher for repeated events than for self-knowledge ($t(54) = 3.50, p = .005$, Hedges' $g = 0.41$). There was no difference in the remaining pairs. In the high school condition, nostalgia intensity

¹¹ In one month condition, mean nostalgia ratings for all events were below the mid-point (one sample t-test; unique events, repeated events, autobiographical facts, self-knowledge, respectively, $ts(54) = -6.02, -12.07, -15.17, -13.37; ps < .001$; Hedges' $gs = -0.80, -1.60, -2.02, -1.78$). Therefore, we considered the data from one month condition as not to be nostalgic responses, and detailed results of ANOVA were not reported, and they were excluded from the GLMM analysis.

was significantly higher for unique and repeated events respectively than for self-knowledge ($ts(54) = 4.56, 5.10; ps < .001$; Hedges' $gs = 0.61, 0.60$) and for autobiographical facts ($ts(54) = 3.21, 2.98; ps < .05$; Hedges' $gs = 0.42, 0.40$). These results were partially consistent with the prediction that repeated events and autobiographical facts would produce greater nostalgia in conditions representing the remote past (the primary school condition), and consistent with the prediction that unique and repeated events would induce greater nostalgia in conditions representing the more recent past (the high school condition). Thus our hypothesis was partially supported. **[Insert Figure 2 here]**

Involuntary memory associated with cued retrieval

Associated memories were spontaneously retrieved in 729 cases out of the 1300 that excluded duplicate memories, or approximately 56% of the total. An ANOVA on frequency found a significant main effect of temporal distance ($F(1.98, 106.81) = 20.00, MSE = 0.46, p < .001, \eta^2_G = .04$). Multiple comparisons indicated no significant difference between primary and high school conditions ($t(54) = 1.12, p = .269, \text{Hedges' } g = -0.09$), but significantly more associated memories in primary and high school condition than in the one month condition ($ts(54) = 4.81, 5.72; ps < .001; \text{Hedges' } gs = 0.39, 0.48$). The main effect of memory content was not significant ($F(2.52, 136) = 0.32, MSE = 0.55, p = .775, \eta^2_G = .00$). Further, the interaction between memory content and temporal distance was significant ($F(4.92, 265.78) = 3.61, MSE = 0.34, p = .004, \eta^2_G = .01$), and a simple main effects test revealed significant main effects of

memory content in the high school and one month conditions ($F(2.74, 147.85) = 2.80$, $F(2.75, 148.38) = 3.76$; $MSEs = 0.32, 0.36$; $ps = .047, .015$; $\eta^2_{GS} = .02, .03$), as well as significant main effects of temporal distance for repeated events, autobiographical facts, and self-knowledge, $F_s = 28.60, 5.75, 4.83$; $MSEs = 0.31, 0.25, 0.40$; $ps < .05$; $\eta^2_{GS} = .14, .03, .03$). Multiple comparisons showed that the frequency of occurrence of associated memory was significantly greater for repeated events than for autobiographical facts in the high school condition ($t(54) = 3.03$, $p = .022$, Hedges' $g = 0.38$). Unique events induced significantly more associated memories than repeated events in the one month condition ($t(54) = 3.83$, $p = .002$, Hedges' $g = 0.46$). These results revealed a bias in the types of memory content that triggered the associated memories, so additional analyses were conducted (see Relationships between memory contents, temporal distance, and nostalgia ratings after controlling for continuity and associated memory).

Continuity of events and facts

Events and facts with continuity from the past to the present are less likely to induce nostalgia because self-discontinuity (especially when negative) triggers high state nostalgia (Sedikides et al., 2015b), although these events and facts occurred in the distant past. Therefore, rules were used to code whether events or facts from primary school and high school continued to the present.¹² Of the 870 primary and high school data points that were considered to arouse

¹² First, only participants aged 20-22 years (including 19-year-olds who were due to turn 20 until March 2022) were recruited for this experiment. Because the last year of primary school, grade 6 (age 12), was approximately 8 years ago for the 20-year-old participants and approximately 10 years ago for the 22-year-old participants, 1: *not continuous as it was a single event*, 2: *continued until more than 10 years ago*, or 3: *continued until 8 or 9 years ago* were defined as not continuous primary school events. As an exception, 4: *continued until 6 or 7 years ago* was defined as not continuous primary school events only for 19-year-old participants, as it was possible for them to have been in primary school 7 years ago. High school events were defined as not continuous if the

nostalgia, 674 were not continuous (i.e., they happened only at that time). This led us to consider that the presence or absence of continuity may have influenced the analysis of the content of memories that enhanced nostalgia, and we therefore conducted additional analyses (see Relationships between memory contents, temporal distance, and nostalgia ratings after controlling for continuity and associated memory).

Relationships between memory contents, temporal distance, and nostalgia ratings after controlling for continuity and associated memory

As noted above, the presence of associated memories and the continuity of events or facts may have functioned as confounding factors. Therefore, additional analyses using a generalized linear mixed effects model (GLMM) were conducted using SAS software (v.9.4)¹³¹⁴.

SAS PROC GLIMMIX fitted multinomial distributions for the Likert scale of nostalgia (intensity of nostalgia: 1-7) with a cumulative logit link. Explanatory variables were memory content (applicable: 0.5, not applicable: -0.5), temporal distance (primary school: 0.5, high school: -0.5), the interaction between memory content and temporal distance, continuity (absence: 0.5, presence: -0.5), and associated (involuntary) memory (absence: 0.5, presence: -

memory was chosen as either 1: not continuous, as it was a single event, 4: continued until 6 or 7 years ago, 5: continued until 4 or 5 years ago, or 6: continued until 2 or 3 years ago (only for 19-21 years-old participants). The basis for determining this number of years was that grade 12 (age 18), the final grade of high school, was approximately two years ago for the 20-year-old participants and approximately four years ago for the 22-year-old participants. The first grade of high school, grade 10 (age 16), was approximately four years earlier for the 20-year-old participants and approximately six years earlier for the 22-year-old participants.

¹³ However, because the calculation of sample size was conducted for ANOVA, it is possible that GLMM analyses may lack statistical power.

¹⁴ The data analysis for this section was generated using SAS software. Copyright © 2012-2020, SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

0.5). The participant was a random intercept, and as a random slope, the model assumed that the interaction effects between memory content, temporal distance, and the two factors differed for each participant. As there were four levels of memory content in total, four similar models with different reference levels¹⁵ for the dummy coding were constructed to test the differences between each pair of memory contents. Table 1 shows the GLMM results.

Tests of the model referred to unique events for dummy coding and demonstrated a significant interaction between autobiographical facts (difference from unique events) and temporal distance. However, the model which referred to self-knowledge and repeated events for dummy coding of memory content did not demonstrate significant interactions between autobiographical facts and temporal distance. Further, events or facts which were not continuous had a higher intensity of nostalgia, as did those that caused associated (involuntary) memories.

These results indicate that the statistical significance of the hypothesized interaction effect partially remained even after controlling for possible confounding factors such as the presence or absence of continuity and associated memory.

[Insert Table 1 here]

Experiment 2: discussion

Experiment 2 was conducted on one day only to replicate the results of Experiment 1 by modifying of the experimental procedure. Participants completed cued retrieval and rated the

¹⁵ Each model has slightly different statistics. Please see Table 1 and the SAS file uploaded to OSF for more information.

presence or absence of events or fact-associated (involuntary) memories, the continuity of events or facts, and other cognitive and affective items, including the intensity of nostalgia. The hypothesis that the types of memory content involved in evoking greater intensity of nostalgia would differ depending on temporal distance from the present was partially supported.

Similarly, the result of Experiment 1 was partially replicated; more specifically, the prediction that repeated events and autobiographical facts would induce greater nostalgia than other types of memory content in the primary school condition was partially consistent with the results.

However, unlike Experiment 1, the intensity of nostalgia for unique events was not significantly different from the other three types of memory content in the primary school condition. This difference may be attributed to the change in temporal distance. Temporal distance from the present was shorter in Experiment 2 than in the primary school condition of Experiment 1, in which only grades 1-3 were considered, because grades 4-6 were added to the possible retrieval period. It is possible that this addition reduced the difficulty of remembering unique events from primary school, resulting in a non-significant difference between unique events and repeated events.

As predicted, in the high school condition, which represented the recent past, unique and repeated events induced a higher intensity of nostalgia than other types of memory content. A temporal distance effect was also found, with greater nostalgia in primary and high school conditions than in the one month condition, supporting the results and proposals of previous studies (Kusumi et al., 2010; Stephan et al., 2012, van Tilburg et al., 2019). Additional analyses

using GLMM with the continuity of events or facts and the presence of associated (involuntary) memory as explanatory factors found that the interaction between memory content and temporal distance partially remained after controlling for these confounding variables.

Comparison of experiments 1 and 2

In Experiment 1, there was a time lag of one week between memory retrieval and rating task, so the validity of the emotional intensity was unclear. However, similar results were produced in Experiment 2 when rating tasks were completed immediately after cued retrieval. From this perspective, the influence of the one-week interval may be considered negligible, such that the interpretation of the results of Experiment 1 remains valid. Further, the source of nostalgia was unknown in Experiment 1. In Experiment 2, nostalgia was high when associated memories involuntarily occurred. However, as mentioned earlier, it became clear that the trends in differences in the intensity of nostalgia for each memory content pair generally remained even when the presence or absence of associated memories was controlled. These results suggest that the network of autobiographical memories increases the intensity of nostalgia, and that it is necessary to control involuntary associations in the future. In the present study, approximately 56% of the overall memories produced associations, a higher occurrence of associations than in previous studies (Mace, 2006; Mace & Kruchten, 2021), which had shown that 39% - 40% of voluntary memories triggered involuntary memories. Although the results cannot be simply compared due to differences in experimental methods and objectives, it is possible that the ease of generating associations depends on the level of abstraction of the

memory content, as the previous experimental tasks required the retrieval of specific memories (Mace, 2006; Mace & Kruchten, 2021), whereas the present task included the retrieval of both episodic and semantic memories.

We were concerned that habits, which were one of the subtypes of autobiographical facts, and repeated events in Experiment 1 were similar because both memories referred to repeated actions. However, the results of the ANOVA in Experiment 2 indicated similar trends to Experiment 1 when school names were used instead of habits. Nevertheless, we could not exclude the possibility that the continuity of events and facts were confounding factors in Experiment 1. Therefore, in Experiment 2, a rating item on continuity was added, and an additional analysis was conducted using GLMM. The analysis produced significant main effects of memory content and a significant interaction between memory content and temporal distance even when the presence or absence of continuity was controlled. Critically, even though the original two-way ANOVA showed significant differences between repeated events and autobiographical facts, and between self-knowledge and autobiographical facts varied with temporal distance, additional analysis using GLMM showed that the only significant interaction between unique events and temporal distance in the model with reference to autobiographical facts (as well as in the model with reference to unique events). This means that autobiographical facts are particularly sensitive to the intensity of nostalgia depending on the presence or absence of the continuity and associated memory, suggesting that these factors need to be controlled for in future studies.

General discussion

To the best of our knowledge, this is the first study of nostalgia that manipulated both the abstraction level of retrieved autobiographical memories and temporal distance. In particular, we consider the present study to be novel in its application of the taxonomy of personal semantics (Renoult et al., 2012) and the methodology of autobiographical memory (Brown & Schopflocher, 1998) to nostalgia research. The present study focused on the relationship between memory content, temporal distance, and emotional intensity, which traditional nostalgia research has not investigated, and examined the content of memories that support the generation of nostalgia. Experiments 1 and 2 clarified that memory contents evoking a greater nostalgia differed depending on the temporal distance (primary versus high school).

Implications for nostalgia research

In the primary school condition, nostalgia was greater for repeated events and autobiographical facts than for self-knowledge, while the other pairs of memory content did not show coherent differences. In the high school condition, unique events and repeated events were more nostalgic than the other memories. These results suggest that the retrieval of more specific memories (unique events and repeated events) that occurred in the recent past tends to be accompanied by greater nostalgia than more abstract memories (autobiographical facts and self-

knowledge), but that abstraction and uniqueness levels might not be crucial in the remote past.

If the uniqueness of an event is an essential factor in inducing nostalgia, then unique events should have induced the greatest nostalgia in all temporal distance conditions, but this did not happen. Therefore, nostalgia can occur even in the absence of episodic uniqueness. Other types of memory content should also be considered, although this inference is consistent with the model that frequent repetition triggers nostalgia (Kusumi et al., 2010).

Previous nostalgia research suggested a variety of mechanisms for the occurrence of nostalgia, with claims that nostalgic experience is supported by episodic memory with reliving (e.g., Evans et al., 2021) and that assumptions about the type of such memories are not needed (e.g., Barrett et al., 2010). Thus, it was unclear what type of memories participants were referring to when they experienced nostalgia. However, the results of the present study have shown that the memories supporting the occurrence of nostalgia are not only episodic memories but also include self-relevant knowledge. This finding suggests that nostalgia can occur not only when accessing the lowest level of episodic memory in the structure of autobiographical memory (Conway, 2005), but also when simply accessing the conceptual self.

The present study also showed that when other memories spontaneously occurred, nostalgia was higher than when such other memories did not occur. Because this experiment only assumed the intrusion of involuntary retrieval as a confounding factor, the interpretation of this result must remain at the correlational level and does not indicate a causal relationship with nostalgia. With this in mind, there is a mechanism whereby involuntary memory is more likely

to occur due to a nostalgia-prone situation (e.g., watching a nostalgic movie, listening to nostalgic music, or instructions for reminiscence) after remembering a voluntary memory. This possibility is supported by the present findings that retrieval from the primary and high school years caused more involuntary memories than retrieval from one month ago, and by the results of Rasmussen et al. (2021), in which talking about one's memories before watching a nostalgic movie caused more recall of event memories and spontaneous remembering of autobiographical memories than watching the movie alone. This possibility needs to be evaluated in future experiments.

Effects of continuity

The continuity measured in Experiment 2 was found to be negatively related to the intensity of nostalgia. These results were partially consistent with the hypothesis that nostalgic recollection occurs with self-discontinuity due to present dissatisfaction and anxiety (Davis, 1979) and with experimental findings that negative self-discontinuity enhances nostalgia (Sedikides et al., 2015b). The reason for the "partial" consistency is that the present study did not provide data indicating that dissatisfaction with the present, or negative changes that occurred between the past and the present, directly triggered nostalgia. In other words, nostalgia may occur even when people consider the past to be the good old days and the present to be a good situation. In sum, the results of this study suggest that events or facts that continue to the present are not strong triggers of nostalgia. This supports the model that frequent repetition

during a specific period in the past with a long time lag from the present trigger nostalgia (Kusumi et al., 2010).

Limitations

The present study has several limitations. The first is that we considered the content of memory as a separate category rather than as a gradient. For example, autobiographical facts are considered relatively abstract in the abstraction model of Renoult et al. (2012), but meta-analytic reviews showed that autobiographical facts partially depend on the medial temporal lobe (MTL) (Grilli & Verfaellie, 2014), especially in parahippocampus (Martinelli et al., 2013). That is, episodic memory and autobiographical facts have partially common retrieval mechanisms in some cases, although the levels of involvement with MTL will differ. Whether or not they have the same retrieval mechanisms would depend on the content and importance of the autobiographical fact, and only the facts with a strong link to the event would also have a strong MTL contribution. Therefore, rather than taking the correspondence between categories of memory content and emotional intensity as a single category, evaluating the details of the recalled memories will be necessary.

Similarly, repeated events are likely to have better or worse connectivity with the unique events (i.e., recollective experiences; Renoult et al., 2016). To examine the mechanism by which repeated exposures enhance nostalgia, it will be necessary to determine how detailed the repeated events are (e.g., Holland et al., 2011), to identify whether one of the events that

occurred multiple times can be retrieved as a single incident (episodic memory), and to characterize each pattern. Thus, future studies are required to elucidate the relationship between personal semantics and nostalgia while capturing personal semantics in a continuous manner. Despite the above problems, the present study was able to show that both episodic memory and personal semantics are involved in the occurrence of nostalgia as the trigger, as a first step.

A second limitation is that we cannot reject the possibility that the particularity of the temporal distance played a role as a confounding factor. The present study defined the primary school years as the remote past and the high school years as the recent past and argued that there is an interaction between temporal distance and the content of memory. However, the high school years are likely to contain more remarkable events for college students, such as preparation for college entrance exams and club activities. In order to control these confounding factors, future studies with different age groups and different temporal distances will be necessary. For example, when participants of different ages reminisce about their high school years, it would be possible to differentiate and sort cases with longer or shorter temporal distances.

Third, the age of the participants was limited. As mentioned in the Introduction, the balance of dependence on episodic and semantic memory tends toward the latter in older age groups (e.g., Levine et al., 2002). This study showed that personal semantics is involved in and supports the generation of nostalgia, even among college students. On this basis, it is necessary to elucidate the predominance of each type of memory and the differences in subjective

experience in older participants.

Finally, because unique events produced levels of nostalgia similar to repeated events in the high school condition, it should be noted that the occurrence of nostalgia is not explained by a single factor such as the uniqueness or repetition of the episode. Instead, it appears to be determined by a combination of multiple factors, such as the meaningfulness of the event, the comfort of the event, among others (e.g., Routledge et al., 2011; van Tilburg et al., 2019).

Despite these problems, this study has shown that the uniqueness of an episode may not be the one and only factor in the occurrence of nostalgia.

Conclusion

The present study clarified the relationship between the level of abstraction (types of memory content), temporal distance, and nostalgia in autobiographical memories. When participants retrieved memories from different periods (primary school and high school), repeated events were associated with high nostalgia in both periods. Moreover, autobiographical facts were associated with high nostalgia in the primary school (remote) period, and unique events were associated with high nostalgia in the high school (recent) period. These results indicate that less abstract memories such as unique events and repeated events in the remote past are retrieved with greater nostalgia, whereas no such relationship is found during the retrieval of memories in recent past condition. Exploratory analysis revealed that the interaction between memory contents and temporal distance was maintained even when the continuity of

events and facts and the presence of involuntary memory were controlled. Previous nostalgia research has focused mainly on event memory retrieval triggered by memory-based procedures (ERT), but not on memory abstraction and specificity levels. The results of the present study suggest that both episodic memory and personal semantics support the occurrence of nostalgia.

The investigation of cognitive features of nostalgia with reference to memory study findings is significant, because focusing on the level of abstraction and detail of memory involved in the occurrence of nostalgia should maximize the intervention effects of nostalgia (e.g., Dennis & Odgen, 2022; Ismail et al., 2018). This is because the difficulty of memory retrieval and recall changes with aging; specifically, older adults recall fewer episodic memories and more semantic details than younger adults (Levine et al., 2002) and also recall more personal semantics (Acevedo-Molina et al., 2020; Renoult et al., 2020). Given that the beneficiaries of nostalgia interventions (e.g., reminiscence) are mainly the older population, it is important to know the level of memory abstraction involved in the occurrence of nostalgia. Therefore, the present study has contributed to the investigation of the actual correspondence between nostalgia and types of memory content and the content of memories that evoke high intensity of nostalgia, at least in younger subjects. The application of findings from autobiographical memory studies to the theoretical and methodological development of nostalgia research provides scaffolding for future research.

Funding

This work was supported by a Grant-in-Aid for Scientific Research (B) [JP16H02837] and a Grant-in-Aid for JSPS Fellows [JP21J21921] from Japan Society for the Promotion of Science (JSPS).

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability

The data and code are available via <https://osf.io/rchdv/>

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References

- Acevedo-Molina, M. C., Matijevic, S., & Grilli, M. D. (2020). Beyond episodic remembering: Elaborative retrieval of lifetime periods in young and older adults. *Memory*, *28*(1), 83–93.
<https://doi.org/10.1080/09658211.2019.1686152>
- Barrett, F. S., Grimm, K. J., Robins, R. W., Wildschut, T., Sedikides, C., & Janata, P. (2010). Music-evoked nostalgia: Affect, memory, and personality. *Emotion*, *10*(3), 390–403.
<https://doi.org/10.1037/a0019006>
- Barrett, F. S., & Janata, P. (2016). Neural responses to nostalgia-evoking music modeled by elements of dynamic musical structure and individual differences in affective traits. *Neuropsychologia*, *91*, 234–246. <https://doi.org/10.1016/j.neuropsychologia.2016.08.012>
- Barsalou, L. W. (1988). The content and organization of autobiographical memories. In U. Neisser & E. Winograd (Eds.), *Remembering reconsidered: Ecological and traditional approaches to the study of memory*, (pp.193–243). Cambridge University Press.
- Brewer, W. F. (1986). What is autobiographical memory? In D. C. Rubin (Ed.), *Autobiographical memory* (pp. 25–49). Cambridge: Cambridge University Press.
- Brown, N. R., & Schopflocher, D. (1998). Event cueing, event clusters, and the temporal distribution of autobiographical memories. *Applied Cognitive Psychology*, *12*(4), 305–319.

[https://doi.org/10.1002/\(sici\)1099-0720\(199808\)12:4<305::aid-acp569>3.0.co;2-5](https://doi.org/10.1002/(sici)1099-0720(199808)12:4<305::aid-acp569>3.0.co;2-5)

Conway, M. A. (2005). Memory and the self. *Journal of Memory and Language*, 53(4), 594–628. <https://doi.org/10.1016/j.jml.2005.08.005>

Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review*, 107(2), 261–288.
<https://doi.org/10.1037/0033-295X.107.2.261>

Davis, F. (1979). *Yearning for yesterday: A sociology of nostalgia*. Free Press.

Davis, M.H. (1980) A multidimensional approach to individual differences in empathy. *JSAS. Catalog of Selected Documents in Psychology*, 10, 85.

de Leeuw, J. R. (2015). jsPsych: a JavaScript library for creating behavioral experiments in a Web browser. *Behavior Research Methods*, 47(1), 1–12. <https://doi.org/10.3758/s13428-014-0458-y>

Dennis, A., & Ogden, J. (2022). Nostalgia, gratitude, or optimism: The impact of a two-week intervention on well-being during COVID-19. *Journal of Happiness Studies*, 23(6), 2613–2634. <https://doi.org/10.1007/s10902-022-00513-6>

Evans, N. D., Reyes, J., Wildschut, T., Sedikides, C., & Fetterman, A. K. (2021). Mental transportation mediates nostalgia’s psychological benefits. *Cognition & Emotion*, 35(1), 84–95. <https://doi.org/10.1080/02699931.2020.1806788>

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*,

41(4), 1149–1160. <https://doi.org/10.3758/BRM.41.4.1149>

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39(2), 175–191. <https://doi.org/10.3758/bf03193146>

Grilli, M. D. (2017). The association of personal semantic memory to identity representations: Insight into higher-order networks of autobiographical contents. *Memory*, 25(10), 1435–1443. <https://doi.org/10.1080/09658211.2017.1315137>

Grilli, M. D., & Verfaellie, M. (2014). Personal semantic memory: Insights from neuropsychological research on amnesia. *Neuropsychologia*, 61, 56–64. <https://doi.org/10.1016/j.neuropsychologia.2014.06.012>

Grilli, M. D., & Verfaellie, M. (2015). Supporting the self-concept with memory: Insight from amnesia. *Social Cognitive and Affective Neuroscience*, 10(12), 1684–1692. <https://doi.org/10.1093/scan/nsv056>

Grilli, M. D., & Verfaellie, M. (2016). Experience-near but not experience-far autobiographical facts depend on the medial temporal lobe for retrieval: Evidence from amnesia. *Neuropsychologia*, 81, 180–185. <https://doi.org/10.1016/j.neuropsychologia.2015.12.023>

Hayashi, F., & Horiuchi, T. (1997). A study in cognitive complexity of the self: An evaluation of the Linville's index. *The Japanese Journal of Psychology*, 67(6), 452–457. <https://doi.org/10.4992/jjpsy.67.452>

Hepper, E. G., Ritchie, T. D., Sedikides, C., & Wildschut, T. (2012). Odyssey's end: Lay

conceptions of nostalgia reflect its original Homeric meaning. *Emotion*, 12(1), 102–119.

<https://doi.org/10.1037/a0025167>

Hepper, E. G., Wildschut, T., Sedikides, C., Ritchie, T. D., Yung, Y.-F., Hansen, N.,

Abakoumkin, G., Arikian, G., Cisek, S. Z., Demassosso, D. B., Gebauer, J. E., Gerber, J. P.,

González, R., Kusumi, T., Misra, G., Rusu, M., Ryan, O., Stephan, E., Vingerhoets, A. J.

J., & Zhou, X. (2014). Pancultural nostalgia: Prototypical conceptions across cultures.

Emotion, 14(4), 733–747. <https://doi.org/10.1037/a0036790>

Himichi, T., Osanai, H., Goto, T., Fujita, H., Kawamura, Y., Davis, M., H., & Nomura, M.

(2017). Development of a Japanese version of the Interpersonal Reactivity Index. *The*

Japanese Journal of Psychology, 88(1). 61-71. <https://doi.org/10.4992/jjpsy.88.15218>

Holland, A. C., Addis, D. R., & Kensinger, E. A. (2011). The neural correlates of specific

versus general autobiographical memory construction and elaboration. *Neuropsychologia*,

49(12), 3164–3177. <https://doi.org/10.1016/j.neuropsychologia.2011.07.015>

Iseki, R. (2021). Anovakun (Version 4.8.6). Retrieved from

<http://riseki.php.xdomain.jp/index.php?ANOVA%E5%90%9B>.

Ismail, S., Christopher, G., Dodd, E., Wildschut, T., Sedikides, C., Ingram, T. A., Jones, R. W.,

Noonan, K. A., Tingley, D., & Cheston, R. (2018). Psychological and mnemonic benefits

of nostalgia for people with dementia. *Journal of Alzheimer's Disease*, 65(4), 1327–1344.

<https://doi.org/10.3233/JAD-180075>

Juhl, J., Wildschut, T., Sedikides, C., Diebel, T., Cheung, W. Y., & Vingerhoets, A. J. J. M.

- (2020). Nostalgia proneness and empathy: Generality, underlying mechanism, and implications for prosocial behavior. *Journal of Personality*, 88(3), 485–500. <https://doi.org/10.1111/jopy.12505>
- Klein, S. B., & Lax, M. L. (2010). The unanticipated resilience of trait self-knowledge in the face of neural damage. *Memory*, 18(8), 918–948.
<https://doi.org/10.1080/09658211.2010.524651>
- Kopelman, M. D., Wilson, B. A., & Baddeley, A. D. (1989). The autobiographical memory interview: A new assessment of autobiographical and personal semantic memory in amnesic patients. *Journal of Clinical and Experimental Neuropsychology*, 11(5), 724–744.
<https://doi.org/10.1080/01688638908400928>
- Kusumi, T. (2021). Cognitive-affective aspects and functions of nostalgia: Individual differences and age-related changes. *Japanese Psychological Review*, 64(1), 5-28.
https://doi.org/10.24602/sjpr.64.1_5
- Kusumi, T., Matsuda, K., & Sugimori, E. (2010). The effects of aging on nostalgia in consumers' advertisement processing. *The Japanese Psychological Research*, 52(3), 150–162. <https://doi.org/10.1111/j.1468-5884.2010.00431.x>
- Leboe, J. P., & Ansons, T. L. (2006). On misattributing good remembering to a happy past: An investigation into the cognitive roots of nostalgia. *Emotion*, 6(4), 596–610.
<https://doi.org/10.1037/1528-3542.6.4.596>
- Levine, B., Svoboda, E., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and

- autobiographical memory: Dissociating episodic from semantic retrieval. *Psychology and Aging*, *17*(4), 677–689. <https://doi.org/10.1037//0882-7974.17.4.677>
- Mace, J. H. (2006). Episodic remembering creates access to involuntary conscious memory: Demonstrating involuntary recall on a voluntary recall task. *Memory*, *14*(8), 917–924. <https://doi.org/10.1080/09658210600759766>
- Mace, J. H., & Kruchten, E. A. (2021). Involuntary memory production during voluntary memory production: Perceived usefulness, relevance, and intrusiveness. *Memory*, 1–11. <https://doi.org/10.1080/09658211.2021.1998540>
- Martinelli, P., Sperduti, M., & Piolino, P. (2013). Neural substrates of the self-memory system: New insights from a meta-analysis. *Human Brain Mapping*, *34*(7), 1515–1529. <https://doi.org/10.1002/hbm.22008>
- Neisser, U. (1988). Five kinds of self knowledge. *Philosophical Psychology*, *1*(1), 35–59. <https://doi.org/10.1080/09515088808572924>
- Nigro, G.N., & Neisser, U. (1983). Point of view in personal memories. *Cognitive Psychology*, *15*, 467-482.
- Oba, K., Noriuchi, M., Atomi, T., Moriguchi, Y., & Kikuchi, Y. (2016). Memory and reward systems coproduce “nostalgic” experiences in the brain. *Social Cognitive and Affective Neuroscience*, *11*(7), 1069–1077. <https://doi.org/10.1093/scan/nsv073>
- Rasmussen, K. W., Salgado, S., Daustrand, M., & Berntsen, D. (2021). Using nostalgia films to stimulate spontaneous autobiographical remembering in Alzheimer’s disease. *Journal of*

Applied Research in Memory and Cognition. <https://doi.org/10.1016/j.jarmac.2020.11.001>

Rathbone, C. J., Holmes, E. A., Murphy, S. E., & Ellis, J. A. (2015). Autobiographical memory and well-being in aging: The central role of semantic self-images. *Consciousness and Cognition*, *33*, 422–431. <https://doi.org/10.1016/j.concog.2015.02.017>

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing. Retrieved from <https://www.R-project.org/>.

Reid, C. A., Green, J. D., Wildschut, T., & Sedikides, C. (2015). Scent-evoked nostalgia. *Memory*, *23*(2), 157–166. <https://doi.org/10.1080/09658211.2013.876048>

Renoult, L., Armson, M. J., Diamond, N. B., Fan, C. L., Jeyakumar, N., Levesque, L., Oliva, L., McKinnon, M., Papadopoulos, A., Selarka, D., St Jacques, P. L., & Levine, B. (2020). Classification of general and personal semantic details in the Autobiographical Interview. *Neuropsychologia*, *144*, 107501. <https://doi.org/10.1016/j.neuropsychologia.2020.107501>

Renoult, L., Davidson, P. S. R., Palombo, D. J., Moscovitch, M., & Levine, B. (2012). Personal semantics: At the crossroads of semantic and episodic memory. *Trends in Cognitive Sciences*, *16*(11), 550–558. <https://doi.org/10.1016/j.tics.2012.09.003>

Renoult, L., Tanguay, A., Beaudry, M., Tavakoli, P., Rabipour, S., Campbell, K., Moscovitch, M., Levine, B., & Davidson, P. S. R. (2016). Personal semantics: Is it distinct from episodic and semantic memory? An electrophysiological study of memory for autobiographical facts and repeated events in honor of Shlomo Bentin. *Neuropsychologia*,

83, 242–256. <https://doi.org/10.1016/j.neuropsychologia.2015.08.013>

Rizopoulos, D. (2006). ltm: An R package for latent variable modeling and item response analysis. *Journal of Statistical Software*, *17*(5), 1–25. <https://doi.org/10.18637/jss.v017.i05>

Routledge, C., Arndt, J., Sedikides, C., & Wildschut, T. (2008). A blast from the past: The terror management function of nostalgia. *Journal of Experimental Social Psychology*, *44*(1), 132–140. <https://doi.org/10.1016/j.jesp.2006.11.001>

Routledge, C., Arndt, J., Wildschut, T., Sedikides, C., Hart, C. M., Juhl, J., Vingerhoets, A. J. J. M., & Schlotz, W. (2011). The past makes the present meaningful: Nostalgia as an existential resource. *Journal of Personality and Social Psychology*, *101*(3), 638–652. <https://doi.org/10.1037/a0024292>

Rutt, J. L., & Löckenhoff, C. E. (2016). From past to future: Temporal self-continuity across the life span. *Psychology and Aging*, *31*(6), 631–639. <https://doi.org/10.1037/pag0000090>

Sedikides, C., Wildschut, T., Routledge, C., & Arndt, J. (2015b). Nostalgia counteracts self-discontinuity and restores self-continuity. *European Journal of Social Psychology*, *45*(1), 52–61. <https://doi.org/10.1002/ejsp.2073>

Sedikides, C., Wildschut, T., Routledge, C., Arndt, J., Hepper, E. G., & Zhou, X. (2015a). To Nostalgize: Mixing memory with affect and desire. *Advances in Experimental Social Psychology* (Vol. 51, pp. 189–273). Academic Press. <https://doi.org/10.1016/bs.aesp.2014.10.001>

Shogakukan Unabridged Dictionary of the Japanese Language. (2007). *JapanKnowledge Lib*:

Natsukashisa. <https://japanknowledge.com/lib/display/?lid=20020322cce6NxJ84xMF>.

Stephan, E., Sedikides, C., & Wildschut, T. (2012). Mental travel into the past: Differentiating recollections of nostalgic, ordinary, and positive events. *European Journal of Social Psychology*, *42*(3), 290–298. <https://doi.org/10.1002/ejsp.1865>

Tanguay, A. N., Benton, L., Romio, L., Sievers, C., Davidson, P. S. R., & Renault, L. (2018). The ERP correlates of self-knowledge: Are assessments of one's past, present, and future traits closer to semantic or episodic memory? *Neuropsychologia*, *110*, 65–83.
<https://doi.org/10.1016/j.neuropsychologia.2017.10.024>

Torchiano, M. (2020). *effsize*: Efficient effect size computation. Retrieved from
<https://CRAN.R-project.org/package=effsize>

van Tilburg, W. A. P., Bruder, M., Wildschut, T., Sedikides, C., & Göritz, A. S. (2019). An appraisal profile of nostalgia. *Emotion*, *19*(1), 21–36. <https://doi.org/10.1037/emo0000417>

Vess, M., Arndt, J., Routledge, C., Sedikides, C., & Wildschut, T. (2012). Nostalgia as a resource for the self. *Self and Identity*, *11*(3), 273–284.
<https://doi.org/10.1080/15298868.2010.521452>

Westfall, J. (2016). PANGEA: Power ANalysis for GEneral Anova designs. Retrieved from
<http://jakewestfall.org/publications/pangea.pdf>

Westmacott, R., Leach, L., Freedman, M., & Moscovitch, M. (2001). Different patterns of autobiographical memory loss in semantic dementia and medial temporal lobe amnesia: A challenge to consolidation theory. *Neurocase*, *7*(1), 37–55.

<https://doi.org/10.1093/neucas/7.1.37>

Westmacott, R., & Moscovitch, M. (2003). The contribution of autobiographical significance to semantic memory. *Memory & Cognition*, 31(5), 761–774.

<https://doi.org/10.3758/bf03196114>

Wheeler, M. A., Stuss, D. T., & Tulving, E. (1997). Toward a theory of episodic memory: The frontal lobes and autonoetic consciousness. *Psychological Bulletin*, 121(3), 331–354.

<https://doi.org/10.1037/0033-2909.121.3.331>

Wildschut, T., Sedikides, C., Arndt, J., & Routledge, C. (2006). Nostalgia: Content, triggers, functions. *Journal of Personality and Social Psychology*, 91(5), 975–993.

<https://doi.org/10.1037/0022-3514.91.5.975>

Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology*, 9(2), 1–27. <https://doi.org/10.1037/h0025848>

Zizak, D. M., & Reber, A. S. (2004). Implicit preferences: the role(s) of familiarity in the structural mere exposure effect. *Consciousness and Cognition*, 13(2), 336–362.

<https://doi.org/10.1016/j.concog.2003.12.003>

Figure 1.

Mean Ratings of Nostalgia (1-7 points) \pm SD in Each Condition (Experiment 1)

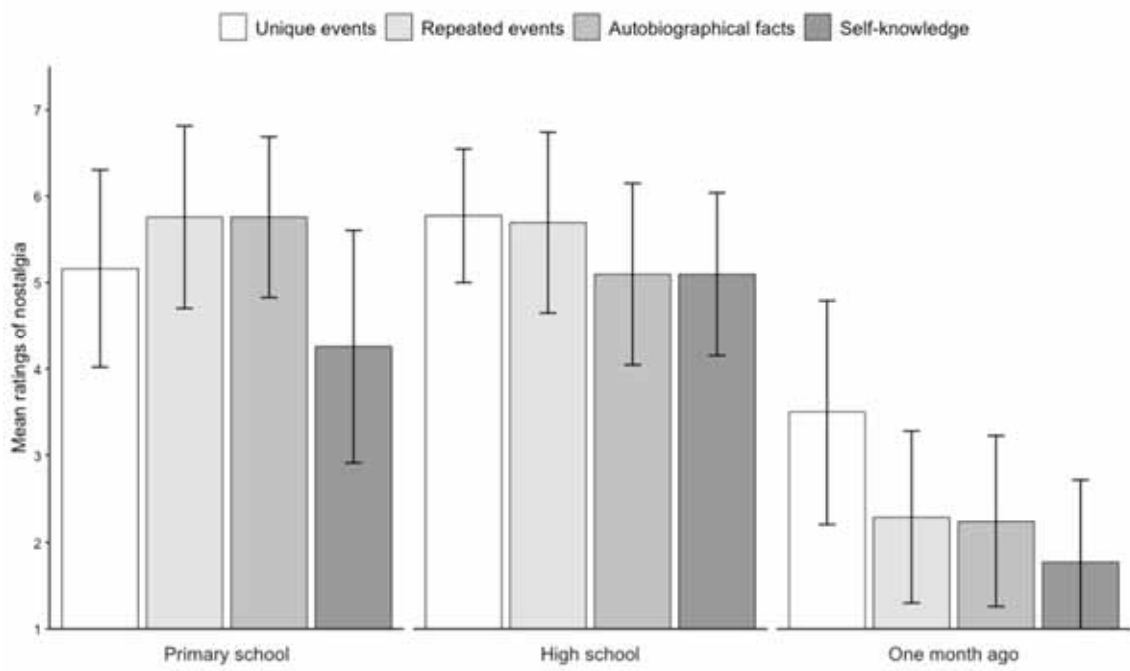


Figure 2.

Mean Ratings of Nostalgia (1-7 points) \pm SD in Each Condition (Experiment 2)

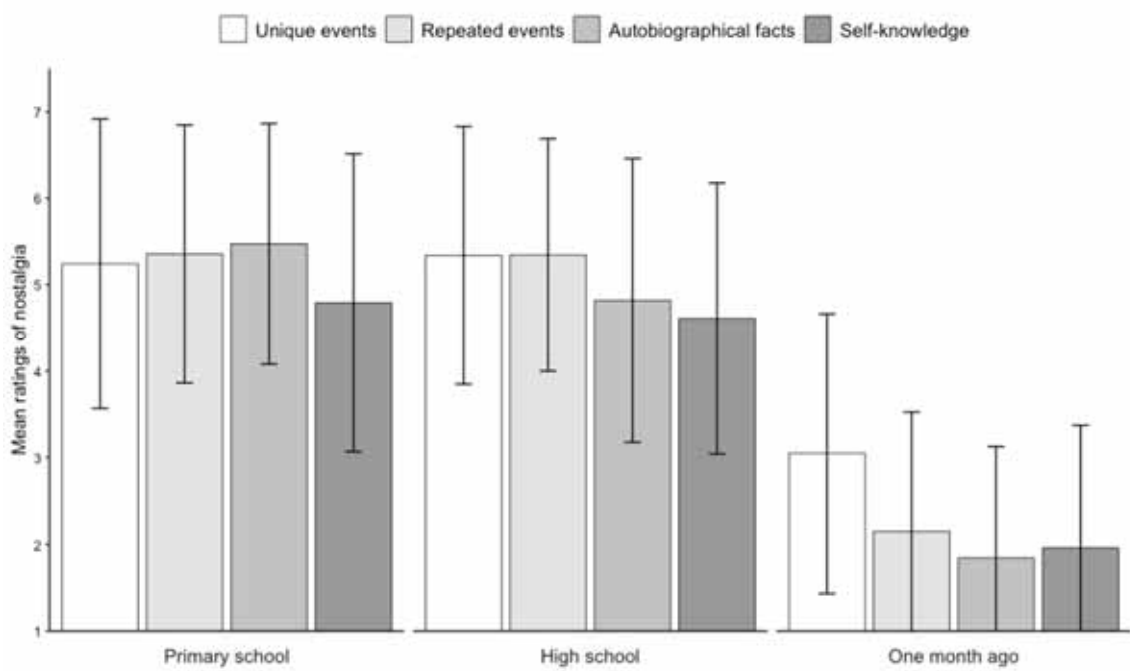


Table 1

Results of generalized linear mixed effects model of the relationship between types of memory contents, temporal distance, and nostalgia ratings, after controlling for continuity and associated memory.

Model	Effects	Estimate	<i>SE</i>	<i>df</i>	<i>t</i>	<i>p</i>
Model with						
reference to						
unique events	Repeated events	0.01	.18	54	0.07	.948
	Autobiographical facts	0.06	.19	54	0.31	.757
	Self-knowledge	-0.85	.20	54	-4.33	<.001
	Temporal distance	0.89	.30	54	2.92	.005
	Repeated events x Temporal distance	0.31	.37	54	0.85	.397
	Autobiographical facts x Temporal distance	0.99	.37	54	2.69	.009
	Self-knowledge x Temporal distance	0.27	.38	54	0.71	.479
	Continuity	0.85	.19	423	4.53	<.001
	Associated memory	-0.92	.17	423	-5.47	<.001
Model with						
reference to						
repeated events	Unique events	-0.01	.18	54	-0.06	.953
	Autobiographical facts	0.05	.19	54	0.25	.801
	Self-knowledge	-0.87	.19	54	-4.50	<.001
	Temporal distance	0.57	.31	54	1.87	.067
	Unique events x Temporal distance	-0.33	.38	54	-0.87	.390
	Autobiographical facts x Temporal distance	0.68	.36	54	1.87	.067
	Self-knowledge x Temporal distance	-0.04	.38	54	-0.10	.925
	Continuity	0.85	.19	423	4.52	<.001
	Associated memory	-0.92	.17	423	-5.44	<.001

Model with
reference to
autobiographical

facts	Unique events	-0.06	.19	54	-0.30	.762
	Repeated events	-0.05	.19	54	-0.25	.800
	Self-knowledge	-0.92	.19	54	-4.76	<.001
	Temporal distance	-0.11	.31	54	-0.36	.717
	Unique events x Temporal distance	-1.01	.38	54	-2.66	.010
	Repeated events x Temporal distance	-0.68	.36	54	-1.88	.066
	Self-knowledge x Temporal distance	-0.72	.38	54	-1.90	.063
	Continuity	0.85	.19	423	4.53	<.001
	Associated memory	-0.92	.17	423	-5.44	<.001

Model with
reference to

self-knowledge	Unique events	0.84	.19	54	4.46	<.001
	Repeated events	0.86	.18	54	4.65	<.001
	Autobiographical facts	0.90	.18	54	4.89	<.001
	Temporal distance	0.60	.31	54	1.96	.055
	Unique events x Temporal distance	-0.28	.38	54	-0.76	.452
	Repeated events x Temporal distance	0.04	.36	54	0.10	.922
	Autobiographical facts x Temporal distance	0.71	.36	54	1.98	.052
	Continuity	0.82	.18	423	4.48	<.001
	Associated memory	-0.90	.17	423	-5.42	<.001

Note. $N = 870$.