Scent-Evoked Nostalgia

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Abstract

Can scents evoke nostalgia; what would the psychological implications of such an evocation be? Participants sampled 12 scents and rated the extent to which each scent was familiar, arousing, and autobiographically relevant, as well as the extent to which each scent elicited nostalgia. Participants who were high (compared to low) in nostalgia proneness reported more scent-evoked nostalgia, and scents elicited greater nostalgia to the extent that they were arousing, familiar, and autobiographically relevant. Scent-evoked nostalgia predicted higher levels of positive affect, self-esteem, self-continuity, optimism, social connectedness, and meaning in life. Additionally, scent-evoked nostalgia was characterized by more positive emotions than either non-nostalgic autobiographical memories or non-nostalgic non-autobiographical memories. Finally, scent-evoked nostalgia predicted in-the-moment feelings of personal (general or object-specific) nostalgia. The findings represent a foray into understanding the triggers and affective signature.

Scent-Evoked Nostalgia

The kitchen smells of yeast, a nostalgic smell. It reminds me of other kitchens, kitchens that were mine. It smells of mothers; … It smells of me, in former times, when I was a mother.

--- Margaret Atwood, *The Handmaid's Tale* (1998, p. 47)

A wave of recent research has established nostalgia as a self-conscious emotion and has yielded insights into its subjective experience. Nostalgia, a sentimental longing for one's valued past, entails bittersweet affect, albeit considerably more positive than negative, and refers to momentous occasions where the self and close others come together (e.g., birthdays, graduations, anniversaries, reunions, cultural rituals such as Thanksgiving) (Sedikides, Wildschut, Arndt, & Routledge, 2006, 2008). Importantly, nostalgia serves central psychological functions. Nostalgic reverie increases positive affect (Stephan, Sedikides, & Wildschut, 2012; Wildschut, Sedikides, Arndt, & Routledge, 2006), enhances self-esteem (Hepper, Ritchie, Sedikides, & Wildschut, 2012; Wildschut et al., 2006), strengthens self-continuity (i.e., the connection between one's past and one's present; Sedikides, Wildschut, Gaertner, Routledge, & Arndt, 2008; Sedikides et al., 2013), raises optimism (Cheung et al., in press), instills a sense of social connectedness (Hepper et al., 2012; Zhou, Sedikides, Wildschut, & Gao, 2008), and imbues life with meaning (Routledge et al., 2011; Routledge, Wildschut, Sedikides, Juhl, & Arndt, 2012).

In all of past research, nostalgia has been induced through narrative tasks, song lyrics, or music. In the case of narrative tasks, participants are typically asked to reflect on a nostalgic (vs. ordinary autobiographical) experience, summarize it with keywords, and write a brief essay about it (Routledge, Arndt, Sedikides, & Wildschut, 2008; Wildschut et al., 2006). In the case of song lyrics, participants read lyrics of a song that they previously identified as personally

nostalgic (vs. lyrics of a song that another participant identified as personally nostalgic) (Cheung et al., in press, Study 4; Routledge et al., 2011). In the case of music, participants listen to a variety of brief musical excerpts (Barrett et al., 2010) or to a particular song that is considered to be evocative of nostalgia, as determined by pre-testing (vs. a non-nostalgic song) (Cheung et al., in press, Study 3; Sedikides et al., 2013). In all cases, the ensuing experience of nostalgia is assessed via validated scales, such as a 3-item general nostalgia scale (Wildschut et al., 2006) or a 20-item object-specific nostalgia scale (Batcho, 1995).

We would like to describe in more detail research on music-evoked nostalgia, as it is particularly relevant to our current concerns. Barrett et al. (2010) reported that 26% of 6720 brief musical excerpts evoked nostalgia (i.e., were rated at least "somewhat nostalgic" in response to the question "How nostalgic does this song make you feel?"). Music elicited greater nostalgia (a) to the extent that it was more arousing, familiar, autobiographically relevant, or emotion-provoking, and (b) among individuals who were high in dispositional proneness to nostalgic engagement. Barrett et al. also compared the emotional profile of songs that elicited nostalgia with the profile of songs that did not elicit nostalgia but did elicit other autobiographical memories and with the profile of songs that elicited neither nostalgia nor other autobiographical memories. Music-evoked nostalgia was more strongly associated with both joy and sadness compared to the other two experiential categories, which, in turn, were more strongly associated with irritation than were nostalgic experiences.

We aimed, in this article, to expand on the elicitors of nostalgia and its accompanying functions. By doing so, we endeavored to widen the scope of nostalgia research, broaden the construct's relevance to psychological functioning, and bolster its ecological validity. We were concerned, in particular, with a new nostalgia elicitor, namely scent-based cues. Scents have a

special link to autobiographical memories, especially emotional ones (Chu & Downes, 2000, 2002; Erlichman & Halpern, 1988). As such, olfactory cues may readily evoke nostalgia, which is tethered to emotional memories (Hepper et al., 2012; Turner, Wildschut, Sedikides, & Gheorghiu, 2013). Many individuals have had the experience of a scent transporting them back to their elementary school or Grandmother's house—experiences likely tinged with nostalgia. The power of scents to provoke vivid and emotionally charged autobiographical memories has been labeled the Proust phenomenon (e.g., Chu & Downs, 2000), after Proust's forceful experience of being jolted back to his childhood upon smelling (and tasting) a tea-soaked cake (Proust, 1922/1960).

Research has validated several elements of the Proust phenomenon. Scent-cued memories are more distant in time relative to memories cued by verbal labels, peaking at ages 6-10 versus ages 11-25 (Chu & Downes, 2000; Willander & Larsson, 2006), thus perhaps having the potential to spark greater nostalgia (Stephan et al., 2012). Also, scent-cued memories are relatively emotional, vivid, and detailed (Chu & Downes, 2002; Herz & Cupchik, 1992). For example, Herz (2004) had participants recall an autobiographical memory via a verbal label (e.g., campfire, freshly mown grass), and then re-recall this memory from olfactory (i.e., oil-based beads), visual (i.e., 5 s film clip), or auditory (5 s sound clip) cues. Scent-cued memories were more emotional and evocative than memories cued via visual or auditory stimuli. In general, scent-cued memories (a) contain more emotional and relevant details than visually-cued memories (Chu & Downes, 2002), and (b) are more strongly linked to a sense of being brought back in time than visually- or verbally-cued memories (Willander & Larsson, 2006).

One reason for the strong link between olfaction and memory emotionality may be that the olfactory bulb is linked to structures such as the amygdala and hippocampus, which are

associated with emotional experience and memory (Buchanan, 2007; Cahill, Babinsky, Markowitsch, & McGaugh, 1995). According to positron emission tomography studies, olfactory cues activate the amygdala more than auditory or visual cues do, while scent-cued (compared to word-cued) memories are associated with greater limbic and temporal lobe activity, which is involved in positive memory processing (Royet et al., 2000). In addition, autobiographical information that is retrieved following an olfactory cue is related to more widespread prefrontal cortex activity, a region involved in autobiographical memory retrieval (Arshamian et al., 2013).

These findings suggest that nostalgia may be elicited by olfactory stimuli. This possibility, however, has received almost no empirical attention. In fact, we are aware of only one study to date that directly links scents to nostalgia. Participants from several countries responded to a scale that assessed scent-evoked feelings; nostalgia was one of the nine resulting feelings (Ferdenzi et al., 2013). Our research zeroes in exclusively on the olfactory elicitation of nostalgia while also examining its accompanying psychological functions. We addressed five issues. *First*, we tested directly whether scents elicit nostalgia. *Second*, we asked whether scents are susceptible to similar contingencies as is music (Barrett et al., 2010) in eliciting nostalgia: do scents evoke stronger nostalgia to the extent that they are more arousing, familiar, or autobiographically relevant, and among nostalgia-prone individuals? *Third*, we wondered whether nostalgia evoked by scents serves the same six psychological functions as nostalgia evoked by narrative writing tasks and exposure to song lyrics/music. These functions (which were not assessed in research on music-induced nostalgia by Barrett et al., 2010) are: positive affect, self-esteem, self-continuity, optimism, social connectedness, and meaning in life (Cheung et al., in press; Hepper et al., 2012; Routledge et al., 2011; Sedikides et al., 2013; Wildschut et

al., 2006; Zhou et al., 2008). *Fourth*, we asked whether scent-evoked nostalgic experiences comprise a similar emotional profile to that of music-induced nostalgic experiences (Barrett et al., 2010). *Finally*, we examined whether scent-evoked nostalgia predicts in-the-moment (i.e., state) feelings of personal nostalgia, be it general or object-specific.

Method

Stimuli

First, we conducted a pilot study to identify the most appropriate scents which we would use for nostalgia evocation in the main study. Undergraduate students ($N = 72$; 31 women, 13 men, 28 unreported) from introductory psychology courses at a large, public university ($M_{age} = 19.34$, $SD_{age} = 2.84$) sampled in a random sequence 33 pleasant and neutral scented oils (e.g., Christmas tree, buttered popcorn, baby powder) obtained from a company (Nature's Garden Wholesale Candle and Soap Supplies) that sells fragrances in 1/2 ounce vials. For each scent, participants indicated how nostalgic it made them feel (1 = *not at all*, 7 = *very much*). Of the 1,378 scent ratings, 718 (52.10%) ratings were at or above the midpoint of this nostalgia scale (i.e., equal to or greater than 4).[1] We retained for use in the main study the 12 scents (out of 33) with the highest corrected item-total correlations (treating scents as items). These selected scents were: Chanel #5 (perfume; .93), purrs and paws (a pet fragrance scented with citrus and fresh flowers; .91), money (.91), eggnog (.88), apple pie (.85), pumpkin pie spice (.83), fresh-cut roses (.82), cappuccino (.81), cotton candy (.80), baby powder (.78), lavender flowers (.78), and oceans (.77). (The numbers in parentheses are corrected item-total correlations in the pilot

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[1] Out of a possible 2,376 (72 participants x 33 scents) ratings, 1,378 ratings were completed. Many participants were unable to rate all scents in the allotted study time. However, given that scents were presented in a random order, we assume that any missing data are missing at random.

study.) The selected scents were not necessarily the scents with the highest mean level of

nostalgia evocation. In fact, the three scents with the highest level of nostalgia evocation (i.e.,

Hawaiian suntan, toasted marshmallow, and honeysuckle) were not selected.[2]

Participants

Undergraduate students ($N = 160$; 103 women, 56 men, 1 unreported) from introductory

psychology courses at a large, public, mid-Atlantic university ($M_{age} = 20.46$, $SD_{age} = 3.80$) took

part for course credit. Their ethnicity varied as follows: White/Caucasian = 47.5%,

Black/African-American = 22.5%, Asian = 18.1%, Hispanic/Latino = 3.8%, Other = 7.5%.

Procedure

Students entered the laboratory to participate in a study on "scents and memories." We

first assessed individual differences in dispositional nostalgia. Participants completed the 7-item

Southampton Nostalgia Scale (SNS; Barrett et al., 2010; Routledge et al., 2008), a measure of

dispositional nostalgia. The SNS consists of four items that assess frequency of (e.g., "How often

do you experience nostalgia) or proneness to (e.g., "How prone are you to feeling nostalgia")

nostalgic engagement and three items that assess personal relevance of nostalgic engagement

(e.g., "How valuable is nostalgia for you?", "How important is it for you to bring to mind

nostalgic experiences?") (1 = *not at all*, 7 = *very much*). We averaged the items to form a

dispositional nostalgia index (Cronbach's $\alpha = .93$).

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[2] In the pilot study ($N = 72$), the mean level of scent-evoked nostalgia across all 33 scents
was 3.58 ($SD = 1.24$). In the main study ($N = 160$), the mean level of scent-evoked nostalgia
across the 12 selected scents was 3.74 ($SD = 1.07$). A comparison of these two means revealed
that they were not significantly different from each other, $t(230) = 1.00$, $p = .317$. Thus, on
average, the smaller selection of 12 scents used in the main study did not comprise more
evocative scents than the more comprehensive set of 33 scents used in the pilot study.

Participants proceeded to sample, in random order, the 12 scented oils selected from the

pilot study. We presented the scents in glass test tubes, and we instructed participants to continue

smelling each scent while answering the relevant questions, before moving on to the next scent.

For each scent, participants completed scent-level measures (adapted from Barrett et al., 2010).

They indicated how nostalgic the scent made them feel (i.e., "How nostalgic does this scent

make you feel?"), and also how arousing (i.e., "How exciting/arousing do you find this scent?"),

familiar (i.e., "How familiar is this scent?"), and autobiographically relevant (i.e., "Describe your

autobiographical association with this scent. How personally relevant is this scent?") the scent

was (1 = *not at all*, 7 = *very much*). In addition, participants completed 12 validated items

assessing six psychological functions of nostalgia (two items per function; Cheung et al., in

press; Hepper et al., 2012; Sedikides et al., 2013; Wildschut et al., 2006). Specifically, they rated

the extent to which each scent made them feel (1 = *strongly disagree*, 7 = *strongly agree*):

positive affect ("happy" and "ecstatic;" $\alpha = .85$), self-esteem ("good about myself" and "value

myself more;" $\alpha = .96$), self-continuity ("connected with my past" and "important aspects of my

personality remain the same across time;" $\alpha = .76$), optimism ("ready to take on new challenges"

and "optimistic about my future;" $\alpha = .96$), social connectedness ("connected to loved ones" and

"loved;" $\alpha = .95$), and meaning in life ("life is meaningful" and "life has a purpose;" $\alpha = .99$).

Furthermore, participants indicated (*yes*/*no*) which of 12 discrete emotions (Shaver, Schwartz,

Kirson, & O'Connor, 1987) they experienced in response to each scent. Six of these emotions

were positive (love, affection, joy, excitement, surprise, amazement) and six were negative

(anger, frustration, sadness, loneliness, fear, distress). We calculated the proportion of endorsed

positive and negative emotions for each scent (i.e., the proportion of positive emotions equals the

number of endorsed positive emotions divided by the total number of endorsed emotions; Barrett

et al., 2010). Moreover, we formed an index of mixed emotions by creating a dummy-coded

variable (1 = *endorsement of at least one positive emotion and at least one negative emotion*, 0 =

endorsement of only positive or only negative emotions).

Finally, participants completed two validated state measures of personal nostalgia. One

measure assesses general nostalgia (Turner, Wildschut, & Sedikides, 2012; Wildschut et al.,

2006). It consists of three items: "Right now, I am feeling quite nostalgic," "Right now, I am

having nostalgic feelings," and "I feel nostalgic at the moment" (1 = *strongly disagree*, 6 =

strongly agree; α = .93). The other measure assesses object-specific nostalgia (Batcho, 1995).

For this measure, participants rated how nostalgic they felt for 20 "objects" from when they were

younger. Examples are: my childhood toys, my family, holidays I went on, my pets, my family

house, past TV shows, someone I loved (1 = *not at all nostalgic*, 7 = *very nostalgic*; α = .84).

Demographic questions and debriefing concluded the experimental session.

Results

Do Scents Elicit Nostalgia?

Table 1 presents a rank-ordering of scents based on the number of times each scent was

rated at or above the midpoint of the nostalgia scale ("How nostalgic does this scent make you

feel?"; 1 = *not at all*, 7 = *very much*). Of the 1906 scent presentations, 1027 (53.88%) were rated

at or above the scale midpoint.[3] This is more than double the percentage of musical excerpts in

Barrett et al.'s (2010) study that received such ratings (26%). This high level of nostalgia

experienced in response to scents cannot be attributed to exclusive selection of highly nostalgia-

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[3] Out of a possible 1,920 (160 participants x 12 scents) ratings, 1,906 ratings were
completed. A few participants were unable to rate all scents in the allotted study time. However,
as in the pilot study, we assume that, because scents were presented in a random order, any
missing data are missing at random. We also note that all scents were rated by at least 158
participants.

evoking scents. We discussed this issue in footnote 2. We would also like to add that eight of the 12 selected scents (i.e., purrs and paws, money, eggnog, apple pie, fresh cut roses, cappuccino, cotton candy, oceans) had mean levels of scent-evocation below the scale-midpoint for nostalgia-evocation. We conclude that scents, relative to songs, constitute a potent nostalgia inducer.

Scent-Evoked Nostalgia: Multilevel Model

We collected data at the person level (dispositional nostalgia) and the scent level (each participant's ratings pertaining to each of 12 scents). Due to the multilevel nature of the data and the likelihood that responses to scent-level measures may not be independent within participant, we used mixed effects multilevel models (Raudenbush & Bryk, 2002). Following recommendations by Singer (1998), we centered the person-level measure across participants, and we centered the scent-level measures (except for mixed emotions, which was dummy coded) within participants. We conducted multilevel model analyses within SAS PROC MIXED using restricted maximum likelihood estimation and an unstructured variance/covariance structure.

We first partitioned the variance in scent-evoked nostalgia into between-subjects and within-subjects components by estimating an intercept-only model (Singer, 1998). We obtained an intraclass correlation of .22, $z = 6.89$, $p < .001$. Thus, 22% of the total variance in scent-evoked nostalgia ratings occurs between participants, thereby confirming that the use of multilevel models to analyze the data is appropriate.

Next, we examined whether the person-level measure—dispositional nostalgia as assessed by the SNS—predicted the average strength of scent-evoked nostalgia. We controlled for dependence in the data by treating the intercept as both a fixed and random effect. Dispositional nostalgia significantly predicted strength of scent-evoked nostalgia, $B = .06$, $t(137)$ $= 2.13$, $p = .03$. Participants who were high in dispositional nostalgia reported stronger scent-

evoked nostalgia across scents. These findings are conceptually similar to Barrett et al.'s (2010) in regards to music-evoked nostalgia.

We next estimated a combined multilevel model including scent- and person-level measures, as well as all possible cross-level interactions. To be precise, we regressed scent-evoked nostalgia on the following scent-level predictors: arousal, familiarity, autobiographical relevance, proportion of positive emotions, proportion of negative emotions, and presence (vs. absence) of mixed emotions. We also examined the person-level measure (SNS) again, as well as all possible cross-level interactions. We controlled for dependence in the data by treating the intercept as both a fixed and random effect. We modeled all scent-level predictors, except negative emotions, as both fixed and random effects. We modeled proportion of negative emotions as a fixed effect only, because the association between negative emotions and intensity of scent-evoked nostalgia did not vary significantly between participants (Singer, 1998).[4]

We present the results for this combined multilevel analysis in Table 2. All scent-level predictors significantly predicted scent-evoked nostalgia, with the exception of mixed emotions. On average, participants reported more nostalgia when smelling scents that they found arousing,

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[4] We developed the multilevel model by taking the following steps. First, we estimated a baseline model in which we treated all scent-level predictors treated as fixed effects only. We then compared this baseline model to a second model in which we treated all scent-level predictors as both fixed and random effects. A comparison of these models showed that adding the random effects resulted in a significant decrease in the -2 log likelihood, $\chi^2(27) = 282.37$, $p < .001$, indicating better model fit when the associations between scent-level measures and scent-evoked nostalgia were allowed to vary between participants, which parallels the results of Barrett et al. (2010). Given that results for the second model showed that the association between negative emotions and scent-evoked nostalgia did not vary significantly between participants, we tested a modified final model in which we modeled negative emotions as a fixed effect only. This modification resulted in a significant decrease in the -2 log likelihood, $\chi^2(7) = 16.79$, $p = .03$, indicating better model fit when the association between negative emotions and scent-evoked nostalgia was not allowed to vary between participants (but all other associations were).

familiar, and autobiographically relevant. They also reported more nostalgia when smelling

scents that prompted a greater proportion of positive and of negative emotions. As before, higher

levels of dispositional nostalgia predicted greater scent-evoked nostalgia, albeit marginally. The

analysis did not reveal significant interaction effects between dispositional nostalgia and the

scent-level predictors on scent-evoked nostalgia. In all, the results paralleled those of Barrett et

al. (2010). Scents are subject to similar contingencies as is music in eliciting nostalgia: Scents

evoke stronger nostalgia to the extent that they are more arousing, familiar, or autobiographically

relevant, and to the extent that they engender a higher proportion of positive and of negative

emotions. In the study by Barrett et al. (2010) cross-level interactions involving dispositional

nostalgia also made a minor contribution to predicting, in their case, music-evoked nostalgia.

Scent-Evoked Nostalgia: Psychological Functions

We also examined whether nostalgia elicited by scents serves the same psychological

functions as nostalgia elicited by narrative-writing tasks or song lyrics/music. Stated otherwise,

we examined whether nostalgia evoked by the scents was associated with each of six functions:

positive affect, self-esteem, self-continuity, optimism, social connectedness, and meaning in life.

We used SAS PROC MIXED to run a series of models testing if scent-evoked nostalgia predicts

these six functions. We controlled for dependence in the data by treating the intercepts in these

models as both fixed and random effect (Singer, 1998). We present the results of these analyses

in Table 3. Indeed, higher levels of scent-evoked nostalgia predicted higher levels of scent-

evoked positive affect, self-esteem, self-continuity, optimism, social connectedness, and meaning

in life.

Scent-Evoked Nostalgia: Emotional Profile

What is the emotional profile of scent-evoked nostalgia and how does it compare to that

of music-evoked nostalgia? Following Barrett et al. (2010), we addressed this question by first

distinguishing between three experiential categories: scents that evoke nostalgia (those scents

rated 2 or higher on the nostalgia rating scale: "How nostalgic does this scent make you feel?"),

scents that do not evoke nostalgia but evoke other autobiographical memories (those scents rated

1 on the nostalgia rating scale, and 2 or higher on the autobiographical rating scale: "Please

describe your autobiographical association with this scent"), and scents that neither evoked

nostalgia nor other autobiographical memories (those scents rated 1 on both the nostalgia and the

autobiographical rating scale). We then compared the overall proportions of positive, negative,

and mixed emotional experiences between the three experiential categories. We display, in

Figure 1, the overall proportion of positive, negative, and mixed emotions reported for each

experiential category.[5]

Positive emotions were more prominent for nostalgic scents than for either non-nostalgic

autobiographical scents or for non-nostalgic non-autobiographical scents. For nostalgic scents,

the ratio of positive to negative emotions was 3:1, whereas for non-nostalgic autobiographical

scents this ratio was 0.17:1, and for non-nostalgic non-autobiographical scents this ratio was

0.40:1. Nostalgic scents, then, engender substantially more positive emotionality than the other

two experiential categories.

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[5] For the purpose of these analyses, we defined as nostalgic those scents that were rated 2 or higher (1 = *not at all [nostalgic]*, 7 = *very much [nostalgic]*). This served to differentiate these scents from non-nostalgic scents, that is, scents rated 1. Doing so enabled us to replicate similar analyses reported in Barrett et al. (2010). For the purpose of identifying the number of scent presentations that were rated as nostalgic (Table 1), we used a more stringent criterion: scents were deemed to elicit nostalgia when they received a rating equal to or greater than the scale midpoint (4) (also following Barrett et al., 2010).

Next, we examined whether positive, negative, and mixed emotions were present at significantly different levels among the three experiential categories. We conducted analyses in SAS PROC MIXED (for positive and negative emotions) and PROC GLIMMIX (for mixed emotions, a dichotomous dependent variable), using a Tukey-Kramer adjustment to control the familywise error rate in post-hoc comparisons between the three experiential categories. Given that we examined experienced emotion at the scent-level, we treated the intercept in these models as both fixed and random effect to control for dependence in the data due to individuals rating multiple scents. Experiential category had a significant effect on the presence of positive emotions, $F(2, 1744) = 139.01$, $p < .001$. Participants reported a higher proportion of positive emotions for nostalgic scents ($M = 0.33$, $SD = 0.27$) than for either non-nostalgic autobiographical scents ($M = 0.16$, $SD = 0.17$), $t(1903) = -6.20$, $p < .001$, $d = 0.75$, or non-nostalgic non-autobiographical scents ($M = 0.06$, $SD = 0.12$), $t(1744) = -16.19$, $p < .001$, $d = 1.29$. Experiential category also had a significant effect on the presence of negative emotions, $F(2, 1744) = 20.85$, $p < .001$. Participants reported a lower proportion of negative emotions for nostalgic scents ($M = 0.09$, $SD = 0.17$) than for non-nostalgic non-autobiographical scents ($M = 0.15$, $SD = 0.18$), $t(1744) = 6.46$, $p < .001$, $d = -0.34$, albeit not lower than for non-nostalgic autobiographical scents ($M = 0.10$, $SD = 0.16$), $t(1744) = 0.96$, $p = .60$, $d = -0.06$.

We also examined the presence of mixed emotions in each experiential category. We determined the presence (vs. absence) of mixed emotions experienced (i.e., one or more negative emotions and one or more positive emotions endorsed for a given scent presentation) for each scent and then analyzed this dichotomous variable as a function of experiential category. We ran the statistical analyses in SAS PROC GLIMMIX, which allowed us to model mixed emotions as a dependent variable with a binomial distribution. Experiential category had a marginal effect on

the presence of mixed emotions, $F(2, 1745) = 2.59$, $p = .08$. Compared to nostalgic scents ($M = 0.14$, $SD = 0.35$), participants tended to report a lower proportion of mixed emotions for non-nostalgic non-autobiographical scents ($M = 0.08$, $SD = 0.28$), $t(1745) = -2.10$, $p = .09$, $d = 0.10$, but not so for non-nostalgic autobiographical scents ($M = 0.11$, $SD = 0.31$), $t(1745) = -1.11$, $p = .27$, $d = 0.05$. Note that Barrett et al. (2010) found significant differences among the three experiential categories on mixed emotions.

Does Scent-Evoked Nostalgia Predict State Personal Nostalgia?

Finally, we tested whether scent-evoked nostalgia predicts general (Wildschut et al., 2006) and object-specific (Batcho, 1995) state nostalgia. Both general and object-specific nostalgia were measured at the person-level. Therefore, it was necessary for us also to create a person-level index of scent-evoked nostalgia. We indexed scent-evoked nostalgia for each participant by calculating the average nostalgia rating ("How nostalgic does this scent make you feel?"; 1= *not at all*, 7 = *very much*) across the 12 scents ($\alpha = .80$). We then conducted regression analyses predicting state personal nostalgia from this scent-evoked nostalgia index. Participants who reported higher levels of scent-evoked nostalgia also reported higher levels of general state nostalgia, $\beta = .51$, $t(150) = 7.31$, $p < .001$, and of object-specific state nostalgia, $\beta = .33$, $t(150) = 4.33$, $p < .001$. Scent-evoked nostalgia thus predicted both general and object-specific state nostalgia.

Discussion

Researchers have induced nostalgia through narrative tasks, song lyrics, or music. Capitalizing on suggestive psychological (Chu & Downes, 2002; Herz, 2004; Willander & Larsson, 2006) and neuroscience (Arshamian et al., 2013; Buchanan, 2007; Cahill, Babinsky, Markowitsch, & McGaugh, 1995) evidence, we wondered whether scents could also evoke

nostalgia. In so doing, we aimed to expand the agenda for nostalgia research by (a) identifying new elicitors of the emotion, (b) linking these elicitors to structural and functional aspects of the emotion, and (c) strengthening the ecological validity of the nature and functions of the emotion.

Summary of Findings

The majority of scents (52% in the pilot study, 53% in the main study) received ratings equal to or greater than the midpoint of the nostalgia scale, which is more than double the proportion of musical excerpts receiving similar ratings (i.e., 26%; Barrett et al., 2010). In addition, scent-evoked nostalgia was subject to similar contingencies as music-evoked nostalgia (Barrett et al., 2010). Scents rated as arousing, familiar, or autobiographically relevant were particularly likely to elicit nostalgia, as were scents linked to a greater proportion of positive and of negative emotions. Also, participants who were especially prone to nostalgic reverie reported greater scent-evoked nostalgia. Moreover, nostalgia elicited by scents served the same psychological functions as nostalgia prompted by narratives or song lyrics/music (Cheung et al., in press; Hepper et al., 2012; Routledge et al., 2011; Sedikides et al., 2013; Wildschut et al., 2006; Zhou et al., 2008): positive affect, self-esteem, self-continuity, optimism, social connectedness, meaning in life.

In general, scent-evoked nostalgia was characterized by a similar emotional profile as music-evoked nostalgia (Barrett et al., 2010). The former engendered greater positive emotion and a higher proportion of positive to negative emotion relative either to non-nostalgic autobiographical scents or non-nostalgic non-autobiographical scents. Scent-evoked nostalgia also engendered lower negative emotion than non-nostalgic non-autobiographical scents. Compared to music-evoked nostalgia (Barrett et al., 2010), scent-evoked nostalgia evinced a less pronounced trend toward engendering mixed emotion (compared to non-nostalgic non-

autobiographical scents). Finally, scent-evoked nostalgia predicted both general and object-specific state nostalgia. Rather than being an idiosyncratic and esoteric form of nostalgic reflection, scent-evoked nostalgia is integrally linked with other, established forms of nostalgic engagement.

Implications and Future Research

The finding that scents can contribute to a powerful evocation of nostalgia adds to the understanding of the nature and prevalence of this emotion. It can be elicited not only by narratives, song lyrics, or music (Barrett et al., 2010; Routledge et al., 2008, 2011), but also by scents. Given the prevalence of scents in one's natural environment, nostalgia is likely to be incited more frequently than three times a week—an estimated average produced on the basis of previous research, which relied exclusively on self-reports (Wildschut et al., 2006).

While testifying to an empirical link between olfaction and nostalgia, the findings raise an issue regarding the relation between nostalgia and its sources (e.g., words, song lyrics, music, scents). The emotional profile of scent-evoked nostalgia (compared to non-nostalgic autobiographical scents and non-nostalgic non-autobiographical scents) was characterized by greater incidence of positive emotions, but not of mixed emotions—at least not to a similar degree as music-evoked nostalgia (compared to non-nostalgic autobiographical songs and non-nostalgic non-autobiographical songs; Barrett et al., 2010). Thus, the precise pattern of accompanying emotional responses may depend partially on the mode of nostalgic evocation. This possibility is worth empirical scrutiny.

Nostalgia prompted by narratives has self-protective benefits. For example, it buffers individuals from self-threat (e.g., negative feedback) (Vess, Arndt, Routledge, Sedikides, & Wildschut, 2010). Does scent-evoked nostalgia also buffer against self-threatening information?

Moreover, do individuals spontaneously resort to scents as an effort to evoke nostalgia for coping with life's vicissitudes (e.g., loneliness, boredom, meaninglessness, self-discontinuity)? These empirical questions could be fruitfully explored in future research.

Coda

In the opening quote, the scent of yeast in a kitchen aroused memories of the author's mother but also of her past self as a mother. Our research indicated the scents can powerfully elicit nostalgia, which, in turn, serves pivotal psychological functions. The findings provide insight into the operation of nostalgia and the modalities that trigger it. We hope that our findings add momentum for additional work in this burgeoning area of inquiry.

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Table 1

Rank Order of Scents in Terms of Capacity to Evoke Nostalgia

Scent	Total presentations	Presentations rated as nostalgic	Percentage of presentations rated as nostalgic
Pumpkin Pie Spice	158	107	67.72
Chanel #5 (perfume)	158	103	65.19
Lavender Flowers	160	99	61.88
Baby Powder	159	97	61.01
Cotton Candy	160	95	59.38
Eggnog	158	90	56.96
Apple Pie	158	88	55.70
Fresh Cut Roses	160	88	55.00
Oceans	159	86	54.09
Cappuccino	160	77	48.13
Purrs and Paws	158	59	37.34
Money	158	38	24.05
Total	1906	1027	53.88

Note. Following Barrett et al. (2010) we scored scent presentations as evoking nostalgia when participants assigned a rating equal to or greater than the midpoint (i.e., 4-7) on the nostalgia scale ("How nostalgic does this scent make you feel?"; 1 = *not at all*, 7 = *very much*).

Table 2

Scent-Evoked Nostalgia as a Function of Scent- and Person-Level Measures: Unstandardized

Parameter Estimates.

Effect	B	df	t	p
Intercept	4.77	137	90.71	< .001
Scent arousal	.28	1497	8.78	< .001
Scent familiarity	.19	1497	5.59	< .001
Scent autobiographical relevance	.36	1497	10.10	< .001
Number of positive emotions	.50	1497	2.99	.003
Number of negative emotions	.37	1497	2.09	.037
Presence (vs. absence) of mixed emotions	.10	1497	0.86	.392
Nostalgia proneness (SNS)	.08	137	1.91	.058
Scent arousal × SNS	-.01	1497	-0.36	.720
Scent familiarity × SNS	.02	1497	0.78	.433
Scent autobiographical relevance × SNS	.03	1497	1.13	.259
Number of positive emotions × SNS	-.16	1497	-1.17	.242
Number of negative emotions × SNS	-.23	1497	-1.52	.129
Presence of mixed emotions × SNS	.16	1497	1.77	.078

Table 3

Psychological Functions as Predicted by Scent-Evoked Nostalgia

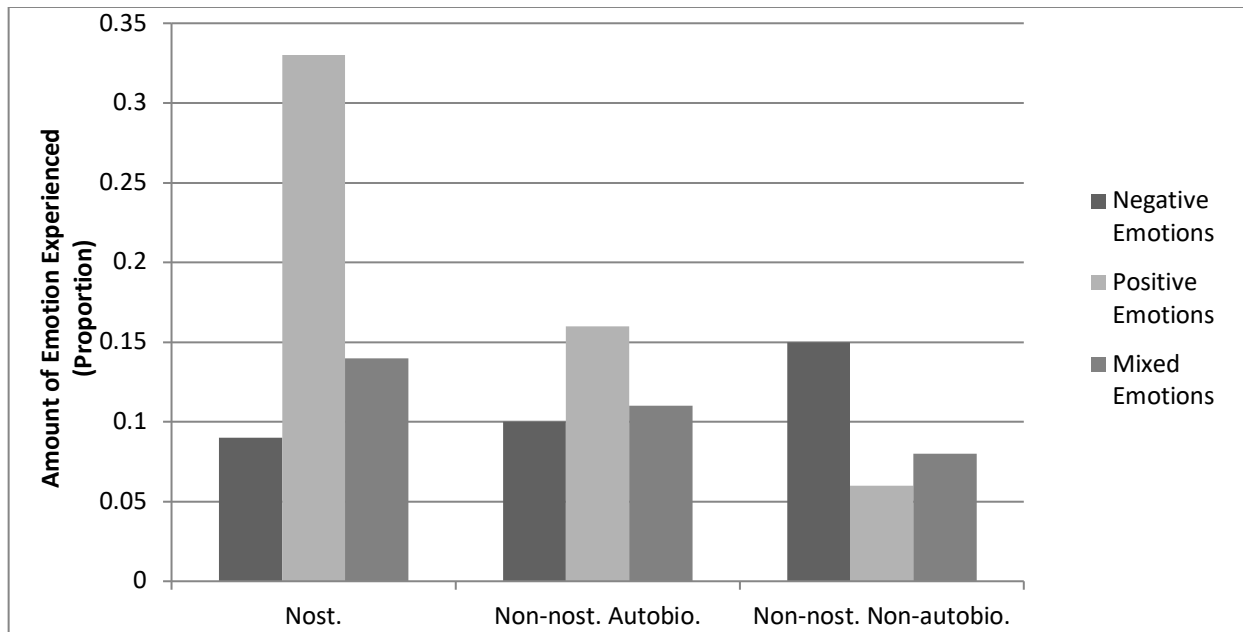| Function	*B*	*df*	*t*	*p*
Positive Affect	.52	1712	35.59	< .001
Self-Esteem	.42	1715	29.76	< .001
Self-Continuity	.52	1714	40.62	< .001
Optimism	.33	1710	23.95	< .001
Social Connectedness	.57	1715	36.32	< .001
Meaning in Life	.41	1711	27.09	< .001

Figure 1. Proportion of positive, negative, and mixed emotions reported across scents for each experiential category (Nost. = nostalgic scents, Non-nost. Autobio. = non-nostalgic autobiographical scents, Non-nost. Non-Autobio. = non-nostalgic non-autobiographical scents).