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A web-based examination of experiences with intrusive thoughts across the adult lifespan

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Abstract

Objectives—Intrusive thoughts and images are common across the adult lifespan, but vary in their consequences. Understanding age-related experiences with intrusive thoughts is important for identifying risk and protective factors for intrusive thought problems across the adult lifespan. This study characterized age trajectories for six aspects of experiences with intrusive thoughts using Internet data collection.

Method—Participants ($N=1427$; ages 18–87) were randomly assigned to suppress (i.e., keep out of mind) or monitor an intrusive thought for one minute, and then later to monitor the thought for a second minute. Participants tracked thought recurrences during each thinking period, then reported their positive and negative affect following each thinking period, as well as their effort expended suppressing the thought, and perceived difficulty controlling the intrusive thought. Multilevel modeling and generalized estimating equations modeled the continuous relationships between age and each dependent variable.

Results—As expected, older age was associated with less decline in positive affect while engaging with an intrusive thought. Interestingly, older age was also associated with a sharper rise and fall of negative affect. Suppression effort increased linearly with age (though perceived difficulty did not). Finally, no age differences were found in either the frequency or duration of the thought's recurrence, adding to previous evidence that older adults function similarly to younger adults in their control of intrusive thoughts, despite certain age-related declines in cognitive functioning.

Conclusion—These findings suggest a dissociation between age-related changes in emotional versus cognitive characteristics of engaging with intrusive thoughts.

Keywords

intrusive thinking; thought suppression; affect; Internet; aging

Intrusive thoughts, defined as unwanted, distressing, and difficult to control thoughts and images, are central to many forms of emotional dysfunction (Clark, 2005). At the same time, intrusive thoughts are commonly experienced by both clinical and non-clinical individuals (Langlois, Freeston, & Ladouceur, 2000), and their consequences differ substantially according to individuals' responses to them (Rachman, 1997). Responses to intrusive thoughts have been proposed to vary systematically with age (Calamari, Janeck, & Deer,

2002), with initial data suggesting that non-clinical younger and older adults differ in their control attempts and immediate emotional states when dealing with intrusive thoughts (Magee & Teachman, 2012). However, little is known about experiences with intrusive thoughts across the entire adult lifespan, which are important for identifying age-related risk and protective factors for experiencing intrusive thought problems (e.g., emotion dysfunction, impaired decision-making). Further, the minimal work that has examined age-related changes in experiences with intrusive thoughts has usually been done in small, relatively homogenous samples that do not include middle-aged adults. To help address these limitations, the current study used Internet-based data collection to examine experiences with intrusive thoughts across the adult lifespan. To our knowledge, this is the first study to examine real-time behavioral experiences with intrusive thoughts using the Internet, as well as the first to look at behavioral experiences with intrusive thoughts in a large adult lifespan sample.

Evidence of Age Differences in Experiences with Intrusive Thoughts

While there are limited data concerning younger versus older adult differences in experiences with intrusive thoughts, initial theory and evidence highlights possible age differences in two areas: 1) affective experiences during engagement with intrusive thoughts, 2) features of attempts to control intrusive thoughts, such as suppression effort, perceived difficulty suppressing thoughts, and thought recurrence. These age differences are significant because they are each thought to influence whether intrusive thoughts have harmful versus trivial consequences (Calamari et al., 2002). Specifically, declining affect and heightened suppression effort, perceived difficulty, and thought recurrence are thought to be interrelated parts of a cycle contributing to longer-term problems with intrusive thoughts (Najmi & Wegner, 2008). Importantly, this cycle is thought to apply across non-clinical and clinical populations, because prominent theories conceptualize the content of ‘normal’ and ‘abnormal’ intrusive thoughts as being comparable and less influential than the way an individual responds to a thought in determining the emotional consequences (Rachman, 1997).

Affective Experiences During Engagement with Intrusive Thoughts

In general, non-clinical older adults tend to report equal or higher positive affect and lower negative affect than younger adults (Charles, 2010), consistent with theories of aging, such as socioemotional selectivity theory, that highlight older adults’ motivation to enhance positive information while diminishing negative information (Carstensen, 1993; 1995). It should be noted that some studies suggest that negative affect or negative emotions may stabilize or even increase in older adulthood (Diener & Suh, 1998; Fiske, Gatz, & Pedersen, 2003), although these changes appear to be frequently accounted for by increased health and functional limitations (Charles, 2010). Notably, the intensity of subjective emotional reactivity is sometimes similar across age groups, with age differences being more apparent on measures of emotional stability (Charles, 2010).

In the context of intrusive thoughts, age differences in the intensity and stability of affective responses may diverge by type of affect. We are aware of only two published behavioral studies that have examined age differences in experiences with intrusive thoughts, and only one of these considered both positive and negative affect. In Magee and Teachman (2012), non-clinical older adults reported higher and more stable positive affect than younger adults throughout a laboratory encounter with an intrusive thought. In contrast, older adults’ negative affect began lower than that of younger adults, but both age groups showed similar increases and subsequent recoveries in negative affect after the introduction of an intrusive thought. In the other behavioral study, which focused only on negative affect among non-clinical individuals, older adults did not differ from younger adults in their overall level of

negative affect, but did show a trend toward greater stability of their negative affect across an extended sequence of intrusive thoughts (Beadel, Green, Hosseinbor, & Teachman, 2013). Finally, in studies examining retrospective, self-reported summaries of daily experiences with intrusive thoughts, negative affect appeared to be less tied to one's level of intrusive thoughts with older age (Brose, Schmiedek, Lövdén, & Lindenberger, 2011), although there is still a relationship among older adults (Stawski, Mogle, & Sliwinski, 2011). These findings suggest that older adults are likely to experience higher positive affect after intrusive thoughts than younger adults, though this is based on a single finding from a relatively small lab study. For negative affect, there is a complex pattern across studies. Given that this study paralleled previous behavioral studies in design and required that older adults would engage in with a real-time intrusive thought, we made the exploratory hypothesis that older adults would experience similar overall increases in negative affect to younger adults, but would experience greater stability in their affect during engagement with intrusive thoughts. Modeling how both positive and negative affect vary across the entire adult lifespan in a large sample is an important next step to clarify affective experiences with intrusive thoughts.

Attempted Control of Intrusive Thoughts

In addition to affective experiences with intrusive thoughts, attempts to control intrusive thoughts influence whether those thoughts have negative consequences (Najmi & Wegner, 2008). One indicator of attempted control, suppression effort, has been considered an ineffective long-term strategy for controlling intrusive thoughts (Wenzlaff & Wegner, 2000), and has been linked to trait anxiety in younger and older adults (Erskine, Kvavilashvili, & Kombrot, 2007). Nevertheless, it may be effective in some cases at reducing actual thought recurrence in the short-term (Abramowitz, Tolin, & Street, 2001). This is pertinent to older age, because there are several possible reasons why suppression effort may be greater in older age. First, older adults may apply greater suppression effort to compensate for aging-related executive functioning difficulties that could make suppression more challenging (Horn & Cattell, 1967; Salthouse, 1991). A second possibility is that older adults may employ more suppression effort to head off the negative affect that frequently follows from intrusive thoughts (Clark, 2005), given evidence for higher antecedent emotion regulation by older (vs. younger) adults (Urry & Gross, 2010). Regulating negative affect after it occurs is more costly in terms of cognitive resources than antecedent regulation of negative affect (Gross & John, 2003). Further, negative affect can sap cognitive resources, leaving older adults less able to use effective emotion regulation strategies (Charles, 2010; Mather & Knight, 2005). Thus, older adults might employ greater effort to preemptively control intrusive thoughts.

Consistent with this possibility, initial behavioral studies have found that non-clinical samples of older adults report extra suppression effort compared to younger adults when presented with an intrusive thought, with this effort mediating increased perceptions of difficulty (Beadel et al., 2013; Magee & Teachman, 2012). This finding differs from self-reported levels of suppression effort in everyday life, in which older adults report less overall effort than younger adults (Erskine et al., 2007). This difference in findings is not surprising because older adults report lower recurrence (than younger adults) of intrusive thoughts in everyday life (Brose et al., 2011; Magee & Teachman, 2012), so have fewer circumstances arise where suppression effort is needed, but in the face of an intrusive thought (as occur in the lab studies where thoughts are experimentally induced), there is evidence that older adults will employ more effort to manage the thought.

In terms of difficulty controlling thoughts during thought suppression, there is greater evidence for age differences in perceived difficulty suppressing thoughts than in actual recurrence. No significant differences between younger and older adults have been found in

the recurrence of intrusive thoughts during control attempts (Magee & Teachman, 2012), and there is even some limited evidence (a non-significant trend) for older adults to report less thought recurrence than younger adults (Beadel et al., 2013). These findings are consistent with the possibility that older adults employ increased suppression effort to compensate for executive functioning difficulties, resulting in increased perceptions of difficulty rather than recurrence differences. Although increases in older adults' recurrence as well as perceived difficulty have been theorized to emerge during longer-term, repeated suppression attempts (Lambert, Smyth, Beadel, & Teachman, 2013), we anticipated that the brief thinking periods in the current study would result in few age differences for actual recurrence, but greater subjective perceptions of effort and difficulty among older adults.

Experiences with Intrusive Thoughts among Middle-Aged Adults

Despite these emerging ideas about affective experiences and attempted control of intrusive thoughts, previous age comparisons have not included middle adulthood, which is typically understood as ranging from 40 to 60 years of age (Lachman, 2004). In terms of affect, some reviews have suggested that middle-aged adults, like younger adults, report equal or less positive affect and sometimes report greater negative affect than older adults (Lachman, 2004). Specific to intrusive thoughts, research has found that younger and older adults are vulnerable to making harmful interpretations of intrusive thoughts that are in line with their age-relevant goals (e.g., moral development vs. cognitive decline; Magee & Teachman, 2012). However, middle-aged adults tend to perceive both typical younger and older-adult goals as relevant (Ebner, Freund, & Baltes, 2006), potentially leaving themselves vulnerable to a wider range of harmful interpretations of intrusive thoughts relative to other age groups. Consistent with this possibility, middle-aged adults have a higher prevalence than all other age groups of obsessive-compulsive disorder (Kessler, Berglund, Demler, Jin, & Walters, 2005), a condition defined by maladaptive affective responding to intrusive thoughts. On the other hand, 'time lived' has been proposed as an important marker of experience practicing emotion regulation (Charles, 2010), meaning that middle-aged adults would likely be more skillful at regulating their emotions after intrusive thoughts than would younger adults. Bringing these research lines together, we expected that within the context of intrusive thoughts, middle-aged adults would share some characteristics with both younger and older adults, and would fall in between these groups in their overall levels of positive and negative affect in response to intrusive thoughts.

In terms of controlling intrusive thoughts, middle-aged adults perform less well than younger adults on measures of processing speed and working memory (Baltes, Staudinger, & Lindenberger, 1999), but generally still have a sufficient combination of functioning and compensatory strategies to avoid the impairment more characteristic of older adulthood (Lachman, 2004). However, concerns about cognitive functioning tend to emerge in middle-adulthood given middle-aged adults are more like older adults than like younger adults in their perceptions of cognitive functioning (Hertzog, McGuire, & Lineweaver, 1998). Thus, the evidence points to a divergence for middle-aged adults when considering perceived difficulty controlling intrusive thoughts versus actual control of thought recurrence. Given middle-aged adults' increased concerns about cognitive functioning, it follows that their suppression effort and perceived difficulty during control attempts will be greater than that of younger adults (although less than that of older adults). For actual recurrence of intrusive thoughts, middle-aged adults are not expected to differ from other age groups, similar to the lack of age differences expected in comparisons between younger and older adults. Thus, we expect a linear increase in perceived difficulty and effort with greater age, despite seeing no age differences in actual recurrence.

The Thought Suppression Paradigm

To test these questions, the current study used the thought suppression paradigm as a method of inducing recurrences of intrusive thoughts (Wenzlaff & Wegner, 2000). We employed the thought suppression paradigm using the web, because this offered an opportunity to examine experiences with intrusive thoughts in everyday environments without substantially lessening the quality of data provided by typical laboratory participants (Gosling, Vazire, Srivastava, & John, 2004; Nosek, Banaji, & Greenwald, 2002). In this paradigm, participants are first randomized to either suppress (i.e., keep out of mind) or monitor an intrusive thought for one thinking period. All participants then complete a subsequent thinking period in which they monitor the same thought. Given the nearly inevitable recurrences of thoughts in the paradigm (Wenzlaff & Wegner, 2000), it is useful for examining *in-vivo* reactions to intrusive thought recurrences. In the current study, we included both suppression and monitoring instructions to allow us to distinguish between the effects of instructed suppression versus being exposed to an intrusive thought. While we expected a potential interaction of age and thinking instructions for perceived difficulty (i.e., the positive association between age and perceived difficulty being stronger under suppression instructions versus monitoring instructions, because suppression is a more resource depleting instruction condition than monitoring), we did not expect age by thinking instruction interactions for the other dependent variables.

Summary and Hypotheses

This study used the web to examine experiences with intrusive thoughts across the adult age range, including middle-aged adults who have not been well-represented in previous age comparisons. We hypothesized that overall, older age would be associated with higher positive affect and more stable negative affect during engagement with intrusive thoughts, though the specific nature of age differences in intensity versus stability of affective reactions was more exploratory. For negative affect in particular, the mixed previous findings made this hypothesis an exploratory one. We also expected that greater age would be linearly associated with increased perceptions of difficulty and effort controlling intrusive thoughts, despite no age differences in actual difficulty (frequency and duration of thought intrusions).

Method

Participants

Participants were 1427 adults aged 18 to 87 from the United States who accessed the publicly-available Project Implicit website (<http://implicit.harvard.edu/>) and were randomized to this study. Two participants were recruited from a retirement community. Eleven participants were excluded from analyses because of dubious age reports (all reported ages between 100 and 106, while the next oldest age reported in the sample was 87). We suspect these reports were facilitated by a selection menu with the oldest selection corresponding to age 106. Participants assigned to the study were automatically marked as ineligible to be assigned to the study again if they made additional visits to the site. Project Implicit samples are more heterogeneous than typical collegiate convenience samples, but not representative of any definable population (Nosek et al., 2007). Because older adults are less well-represented among Project Implicit volunteers than are younger adults, older ages were over-sampled. See Table 1 for the sample's race, ethnicity and gender as a function of age.

Sample Non-Completion—A total of 3067 Project Implicit visitors viewed the informed consent page for the study and 82% (N=2512) provided consent. There was a small association of age with the consent decision, such that older participants were slightly more

likely to agree to participate (for each ten years of age, $OR=1.12, p<.01$). As is common in web research (Dillman et al., 2009), a large number of participants discontinued during the study. Of the 2512 participants who consented, 1427 (57%) provided an answer for every variable that was used for analyses. Of those discontinuing, 606 (56% of non-completers) did so upon introduction of the intrusive thought stimulus. There were no age differences between completers and non-completers ($t_{(2507)}=.93, p=.35, d=.04$).

Materials

Unpleasant Thought Stimulus and Thinking Instructions—As part of the computerized instructions, participants were asked to choose one of their close friends to think about during the subsequent task. They were then presented with the sentence “I hope [name of friend] is in a car accident,” and typed the sentence while inserting the first name of their chosen friend. This thought mirrors real-life intrusive thoughts in terms of its extreme unpleasantness and perceived immorality (Rachman, 1997), and we have used it successfully in previous research with younger adults (Magee & Teachman, 2007) and older adults (Beadel et al., 2013; Magee & Teachman, 2012). Importantly, younger and older adults perceive this thought similarly on a variety of dimensions, such as unpleasantness, immorality, and whether they have previously experienced the thought (Magee & Teachman, 2012). Supporting the feasibility of the Internet administration of the paradigm, the majority of participants (93%) typed this sentence as directed. Notably, whether or not participants followed these instructions (e.g., some typed “I hope no one is in a car accident”) did not significantly alter the pattern of results, so all participants were included in analyses.

Next came a 20-second orientation to the thinking period procedure. Participants were instructed to keep the car accident thought they had just typed continuously in mind and to press and hold the space bar whenever the thought was, in fact, in mind. The screen was black during this time, except for a countdown timer centered at the top, and basic instructions about pressing or releasing the spacebar in the middle. This orientation was followed by the first experimental thinking period in which participants were randomly assigned to one of two thinking conditions: suppression or monitoring. In the *thought suppression* condition, participants were instructed: “Your task now is to NOT THINK ABOUT the thought “[accident thought shown].” This period lasts 60 seconds and you should try to avoid the thought for the entire time.” In the *thought monitoring* condition, instructions were, “You can think about anything. It can be the thought you focused on in the last thinking period “[accident thought shown]” or it can be anything else. This period lasts 60 seconds.” The two conditions’ instructions concluded identically with procedural instructions: “Just like before, PRESS the spacebar and keep it pressed whenever you are thinking about the car accident thought. RELEASE the spacebar whenever you think about something else.” In a second thinking period, all participants were instructed to simply monitor the car accident thought, following the typical thought suppression paradigm (Abramowitz et al., 2001). In each of the two experimental thinking periods, the screen was completely black except for a small 60-second countdown timer positioned at the upper right of the screen.

Affect—Affect was measured with the 20-item *Positive and Negative Affect Schedule* (PANAS; Watson et al., 1988), using the “in the present moment” timeframe. The 10-item positive and negative subscales yield affect scores with good psychometric properties, and validity and reliability have been demonstrated in a sample aged 18 to 91 (see Crawford & Henry, 2004). In the current study, we observed average alphas of .92 and .91, respectively, for the positive and negative items across three measurements.

Attempted Control of Intrusive Thoughts—During each thinking period, participants recorded the *recurrence of intrusive thoughts* by pressing and holding down the computer spacebar. This procedure yielded both frequency (number of key presses during a 60-second period) and duration (time percentage of the 60-second period that the spacebar was pressed) of intrusive thoughts. After each period, participants rated *suppression effort* by answering the question “How hard did you try to NOT think about this thought?” A 5-point scale provided the following options: “I didn’t try at all,” “I tried, but only a little bit,” “I tried a moderate amount,” “I tried rather hard,” and “I tried as hard as possible.” Next, participants rated *perceived difficulty controlling the intrusive thought*. They were asked, “How much difficulty did you experience keeping this thought out of your mind?” and were given the following five response options: “No difficulty,” “A little difficulty,” “Some difficulty,” “Significant difficulty,” and “Extreme difficulty.”

Procedure

All study instructions were presented via the Internet. The consent page informed participants that the study would examine how thoughts and emotions can influence one another and that unpleasant thoughts would be involved; aging was not mentioned. After consenting, participants first completed the PANAS for a baseline assessment of affect. They then completed the thought suppression paradigm consisting of three thinking periods: the 20-second practice period and the two 60-second experimental periods. After the first experimental thinking period, all participants rated how much effort they put into NOT thinking about the thought, how hard it seemed to keep it out of mind, and their affect by again completing the PANAS. Participants then completed the second experimental thinking period in which everyone received instructions to simply monitor the car accident thought. Following this period, participants again rated how much effort they expended, how difficult it felt to keep the thought from mind, and completed a final PANAS affect measure. At the conclusion of the session, participants were presented with debriefing information. This information was also emailed to anyone who began the study so that they would have the chance to see it if they did not finish the study.

Analytic Plan

The primary analyses used two approaches. For positive and negative affect, which had three measurement occasions, we used multilevel modeling to capture both the time-varying measurements of affect within individuals (i.e., level 1) and two possible between-subject moderators of these trajectories, age and thinking instructions (i.e., level 2). For both types of affect, we selected a scaled identity covariance matrix for level 1, which assumed a constant variance over the three measurements, and an unstructured covariance matrix for level 2, which freely estimated the relationship between the random intercept and slope (Heck, Thomas, & Tabata, 2014). For positive affect, we fit a standard multilevel model, while for negative affect, we fit a generalized multilevel model that used a log link function to account for positive skew.

For all other analyses, which had two measurement occasions, we used generalized estimating equations (GEE; Liang & Zeger, 1986), an extension of general linear models that are well-suited for correlated, repeated measurements over time. We specified an unstructured correlation structure for all analyses, so that the correlation among measurement points was estimated. For perceived difficulty and suppression effort, the variables were normally distributed, and an identity link function was selected because it relates predicted values of the model to the observed dependent variables without transformation. For frequency of the intrusive thought, we specified a negative binomial distribution with a log link function because the variable is a count with many instances of zero values. The log link function was selected to account for positive skew. Duration of the

intrusive thought had a bimodal distribution, with one relatively substantial peak at the lower end of the scale, and a second, more moderate peak at the higher end of the scale. To facilitate multinomial methods, we split the duration scores into three categories representing (1) the lowest 50% of duration scores, (2) the next highest 25% of scores, and (3) the top 25% of scores. For the first thinking period, these groupings corresponded to durations of 0–17% (i.e., the thought was in mind for up to 17% of the thinking period), 18–63%, and 64–100%, respectively, whereas for the second thinking period, the groupings corresponded to durations of 0–7%, 8–35%, and 36–100%, respectively. For analyses, we specified a multinomial (ordinal) distribution using a cumulative probit link function.

All participants included in the current analyses provided complete data. Due to the large sample size and the number of statistical tests performed, we set the alpha level at $p < .01$ for statistical tests and confidence intervals. To ease the interpretation of parameters, we scaled age so that all parameters correspond to changes in the dependent variable per 10 years of age, with age centered around the sample mean.

Results

All analyses were conducted using age as a continuous variable; however, six age ranges are presented in tables and graphs for ease of interpretation.

Sample Characteristics

The suppression and monitoring instruction groups did not differ by age ($t_{(1425)} = .73$, $p = .47$, $d = .04$), race ($\chi^2_{(2, N=1410)} = 2.88$, $p = .24$), ethnicity ($\chi^2_{(2, N=1314)} = 1.64$, $p = .44$), sex ($\chi^2_{(1, N=1424)} = 3.61$, $p = .06$), or baseline levels of positive ($t_{(1425)} = .78$, $p = .44$, $d = .04$) or negative affect ($t_{(1425)} = 1.78$, $p = .08$, $d = .09$), indicating that randomization was successful. See Table 1 for summary of tests to examine possible demographic differences as a function of age. Due to age differences in race and ethnicity, we initially included these factors as covariates for all analyses. However, we dropped the variables because they did not alter the pattern of results, suggesting that racial and ethnic group differences across age groups are unlikely to account for the observed age differences.

Thought Suppression Manipulation

The thought suppression manipulation was effective, in that participants who received suppression instructions reported greater suppression effort than did those who received monitoring instructions during the instruction randomization period (period one; $t_{(1405.9)} = 9.50$, $p < .001$, $d = .51$). Note that for t-tests, Levine's test for equality of variances was used, and degrees of freedom were corrected when variances significantly differed.

Age Differences in Experiences with Intrusive Thoughts

Our primary analyses involved estimating the cross-sectional relationships between age and each intrusive thought-related measure. Each analysis included the main effect and interaction terms for age, time, and thinking instructions (suppression vs. monitoring). Further details are provided below by analysis type. Correlations among the six intrusive thought-related measures according to age group are available in the online supplemental appendix.

Positive and Negative Affect—We used multilevel modeling to test whether age would be associated with trajectories of greater positive affect and more stable negative affect over the course of engagement with an intrusive thought. Analyses were initially conducted excluding participants with unusually fast responding to the affect items (the fastest 1.3%), possibly indicating invalid responding. The results did not differ, so the full sample is

reported. We began by estimating the shape of the affect trajectories across the three time points by entering orthogonal terms for linear (coded -1, 0, 1) and quadratic (coded 1, -2, 1) trends. This coding scheme centers time at the midpoint, in this case the measurement after the first thinking period, which stabilizes model estimation by reducing the correlation between the linear and quadratic terms (Raudenbush & Byrk, 2002). Both the linear and quadratic terms accounted for significant variance in the trajectories of positive and negative affect and were retained as fixed effects in the subsequent models (see Table 2). With only three time points, only a single trajectory (i.e., linear or quadratic) can be estimated as a random effect that varies across individuals. For positive affect, the linear term best characterized the change over time, whereas for negative affect, the quadratic term accounted for greater variance. Thus, the final positive affect model sought to explain individual variation in linear trajectories, whereas the negative affect model sought to explain individual variation in quadratic trajectories.

For positive affect, the fixed linear term indicated that, on average, positive affect decreased across the measurements (estimate=-2.06, $SE=.13$, $t(1423)=15.93$, $p<.001$). As seen in Figure 1A, the fixed quadratic term indicated that this decrease lessened over time (estimate=.38, $SE=.03$, $t(1426)=10.91$, $p<.001$). Age was associated with higher individual intercepts (estimate=1.32, $SE=.20$, $t(1423)=6.60$, $p<.001$), and as hypothesized, this effect was qualified by an age by linear time interaction (estimate=.36, $t(1423)=4.27$, $p<.001$). Age explained approximately 2% of the variation in individual slopes. The positive sign of this coefficient indicated that age predicted individual slopes that had a less steep decline in positive affect over time, meaning that older adults maintained their positive affect in the face of intrusive thoughts more than younger adults did. None of the main effects or interactions with thinking instructions were significant ($ps>.01$).

For negative affect, the fixed linear term indicated that, on average, negative affect increased across the measurements (estimate=.08, $SE=.005$, $F(1,4272)=320.67$, $p<.001$), but as seen in Figure 1B, the fixed quadratic term indicated a reversal of this increase over time (estimate=-.07, $SE=.004$, $F(1,4272)=586.12$, $p<.001$). Age was associated with lower individual intercepts (estimate=-.05, $SE=.009$, $F(1,4272)=60.73$, $p<.001$), and this effect was qualified by an age by quadratic time interaction (estimate=-.009, $SE=.003$, $F(1,4272)=22.00$, $p<.001$). Age explained approximately 5% of the variation in individual quadratic trajectories. Unexpectedly, this interaction was negative, indicating that older age predicted a steeper rise and then fall of negative affect over the three measurements. None of the main effects or interactions with thinking instructions were significant ($ps>.01$). Thus, while age was associated with differences in the trajectories of positive affect and negative affect, the age differences moved in different ways over time. Age was associated with a less steep decrease in positive affect over the course of the study, whereas for negative affect, age was associated with greater reactivity and then recovery, as represented by a sharper rise and fall over the three measurements.

Attempted Control of Intrusive Thoughts—Next, we used GEE to examine several indicators of attempted control over intrusive thoughts. For these analyses, we initially tested linear, quadratic, and cubic effects of age. Because neither the quadratic nor cubic terms accounted for significant variance beyond the hypothesized linear effects, we reran analyses without these terms for all variables except perceived difficulty, for which the quadratic term was included given it did account for additional variance. Given our central questions, we report only the results involving the main and interaction effects of age and thinking instructions, but full model results including other effects (e.g., thinking period) can be seen in Table 3.

As expected, there was a main effect of age for suppression effort ($b=.07$, $SE=.03$, Wald Chi-Square=17.98, $p<.001$, $OR=1.07$), with effort being positively associated with age (see Figure 1C). To address whether this association was due to a demand effect, we examined the relationship between age and suppression effort in the group following monitoring instructions. The coefficient and effect size were the same size as in the overall test ($b=.07$, $SE=.03$, Wald Chi-Square=5.10, $p=.02$, $OR=1.07$), making demand effects unlikely to account for this result. Returning to the overall model, there was also a main effect of thinking instructions ($b=.09$, $SE=.07$, Wald Chi-Square=37.32, $p<.001$, $OR=1.10$), with this main effect being qualified by a thinking instructions by thinking period interaction ($b=.56$, $SE=.07$, Wald Chi-Square=68.67, $p<.001$, $OR=1.75$). Examining one thinking period at a time, we found that suppression instructions were associated with greater suppression effort than monitoring instructions during the first thinking period ($b=.65$, $SE=.07$, Wald Chi-square=90.99, $p<.001$, $OR=1.92$), as would be expected given the instructions applied to that period, but not during the second period ($b=.09$, $SE=.07$, Wald Chi-square=1.70, $p=.19$, $OR=1.10$) when all participants were given monitoring instructions. None of the other interaction effects were significant (all $ps>.01$).

Difficulty controlling the intrusive thought was operationalized as participants' ratings of perceived difficulty controlling the thought, as well as the frequency and duration of participants' spacebar presses during the thinking periods. For perceived difficulty controlling the intrusive thought, neither the linear ($b=-.03$, $SE=.03$, Wald Chi-Square=2.87, $p=.09$, $OR=.97$) nor quadratic ($b=.03$, $SE=.02$, Wald Chi-Square=.26, $p=.61$, $OR=1.03$) effects of age were significant, but there was a thinking period by quadratic age interaction ($b=-.05$, $SE=.02$, Wald Chi-square=10.26, $p=.001$, $OR=.95$). Examining one thinking period at a time, we found that while neither period's quadratic age effect was significant, the effect for the first thinking period neared significance ($b=-.02$, $SE=.02$, Wald Chi-square=6.47, $p=.01$, $OR=.98$) and was stronger than that of the second period ($b=.007$, $SE=.02$, Wald Chi-square=.12, $p=.73$, $OR=1.01$). Notice in Figure 1D the more pronounced drop in perceived difficulty for the oldest two age groups during period one. However, given that neither period's age-related effect was significant when examined separately, we are reticent to over-interpret this possible age difference in perceived difficulty. For thinking instructions, the main effect was not significant ($b=.41$, $SE=.06$, Wald Chi-square=4.01, $p=.05$, $OR=1.00$), although there was a thinking instruction by period interaction ($b=.32$, $SE=.09$, Wald Chi-square=10.26, $p=.001$, $OR=1.38$). Examining one thinking period at a time, we found that thought suppression was associated with greater perceived difficulty during the first thinking period ($b=.74$, $SE=.10$, Wald Chi-square=54.84, $p<.001$, $OR=2.09$), but not the second period ($b=.15$, $SE=.10$, Wald Chi-square=2.12, $p=.15$, $OR=1.16$). This matches the findings for suppression effort. None of the other interaction effects were significant (all $ps>.10$).

For frequency, there was no association with age ($b=-.002$, $SE=.04$, Wald Chi-Square=4.32, $p=.04$, $OR=1.00$) or thinking instructions ($b=.03$, $SE=.10$, Wald Chi-Square=.64, $p=.42$, $OR=1.03$), and none of the interactions were significant (all $ps>.01$; see Figure 1E). For duration of intrusive thoughts, the analysis contrasting the three duration categories did not indicate an association with age ($b=-.04$, $SE=.03$, Wald Chi-Square=4.48, $p=.03$, $OR=.96$). There was a significant main effect of thinking instructions ($b=-.17$, $SE=.06$, Wald Chi-Square=16.32, $p<.001$, $OR=.84$), such that suppression instructions were associated with lower duration than monitoring instructions. None of the other interaction effects were significant (all $ps>.01$; see Figure 1F). Taken together, there was little evidence for age differences in difficulty controlling intrusive thoughts, though older adults reported greater effort attempting to control the thoughts.

Discussion

Using a large sample of adults ranging widely in age, this study investigated the relationship between age, modeled as a continuous variable, and experiences with a negative intrusive thought. In line with lifespan theories suggesting emotion reactivity and regulation advantages with older age (e.g., socioemotional selectivity theory; Carstensen, 1993; 1995), older participants reported less steep declines in positive affect over the course of engagement with an intrusive thought. Interestingly, older adults appeared to show greater reactivity but also recovery in negative affect than young adults, as older adults' negative affect grew and subsided at a more rapid pace. In terms of subjective experiences with control attempts, suppression effort increased linearly with age as hypothesized, but there was no straightforward relationship between age and perceived difficulty controlling intrusive thoughts. For actual reported thought recurrences, as expected, there were no age differences in the frequency or duration of intrusive thoughts during our minute-long thinking periods. Additionally, in line with expectations, it appears that experiences with intrusive thoughts are mostly linearly associated with age, with middle-aged adults' scores falling between those of younger and older adults for the dependent variables that demonstrated age differences. Consistent with the literature on aging and intrusive thoughts, these results suggest that greater age may be linearly associated with both benefits (greater maintenance of positive affect) and challenges (greater suppression effort) when dealing with intrusive thoughts.

Given the largely linear pattern of results, middle age may be a key time to educate adults about risk factors for intrusive thought difficulties that may be starting to surface, such as greater suppression effort, which is linked to trait anxiety among younger and older adults (Erskine et al., 2007). The nature of middle age may facilitate "teachable moments," as middle-aged adults are challenged with a variety of life stressors such as the death of parents and novel health problems that may serve as motivating 'wake-up calls' for acquiring new coping skills to handle intrusive thoughts (Aldwin & Levenson, 2001).

Affective Experiences with Intrusive Thoughts

In line with lifespan theories suggesting emotion functioning advantages with older age (e.g., socioemotional selectivity theory; Carstensen, 1993; 1995), the average trajectory of positive affect showed less of a drop for older adults during engagement with the intrusive thought. One potential explanation is that, with time, older adults engaged in motivated strategic processing geared toward maintaining positive affect, such as focusing on single distracter cues, a potentially helpful method of optimizing affect during thought suppression (Wegner, 2011). This explanation fits with evidence that the 'positivity effect' (i.e., preferential processing of positive over negative information) is not apparent in initial, automatic processing, but emerges as the opportunity for strategic processing increases (Mather & Carstensen, 2005).

The pattern for negative affect was different; greater age was associated with greater reactivity and then recovery after the introduction of the intrusive thought. It is possible that this negative reactivity paired with the less steep decline in positive affect in older adulthood reflects the greater co-occurrence of positive and negative emotions with aging that has been found in longitudinal experience sampling studies that measure emotions "in the moment" (Carstensen et al., 2011). An additional interpretation is that older adults may show substantial negative, immediate subjective reactions to highly negative stimuli (Charles, 2010), especially when antecedent emotion regulation is difficult. This was likely the case here given that the thought suppression paradigm makes it difficult to completely avoid the recurrence of intrusive thoughts. However, older adults "bounced back" more quickly than younger adults when given an additional thinking period in which strategic processing could

be implemented, again in line with positivity effect findings that appear as the occasion for strategic processing increases.

A couple of caveats concerning this examination of negative affect should be noted. Given that the experimental thought used in this study is perceived as highly negative across ages, the results may have been different if we had introduced intrusive thoughts that varied in their relevance and/or negativity to older versus younger adults (Beadel et al, 2013). Additionally, there may have been other contributors to negative affect in this study besides the recurrence of the intrusive thought, such as participants disliking the task rather than the return of the thought itself. At the same time, past research examining intrusive thoughts ranging in unpleasantness, perceived immorality, and personal relevance/familiarity has suggested that the current thought is strongly tied to negative affect, and shows continuity with naturally-occurring intrusive thoughts (Magee & Teachman, 2007).

Attempted Control of Intrusive Thoughts

Several clues about age differences in control attempts emerged. Consistent with expectations, suppression effort increased linearly with age. It will be important to investigate whether this effort is tied to different control methods at different ages, and/or linked to compensation due to declines in aspects of cognitive functioning. Further, our findings replicated prior evidence that age is largely unrelated to the recurrence of intrusive thoughts, whether examined as frequency or duration of intrusive thoughts (Beadel et al., 2013; Magee & Teachman, 2012). Perceived difficulty was also not clearly associated with age, which diverged from some prior research. One intriguing explanation for the different age results for effort versus the other outcomes indicating difficulty controlling thoughts is that the current 1-minute thinking periods were not as cognitively demanding as previous studies that used either 5-minute thinking periods (Magee & Teachman, 2012), or multiple sequences of 1 minute 45 second thinking periods (Beadel et al., 2013). According to this idea, older adults may be able to increase their suppression effort for short periods to keep recurrence low (so no age differences occurred for frequency or duration) without experiencing increased perceptions of difficulty.

Using the Web to Study Intrusive Thoughts

This study demonstrates the feasibility of web research for examining experiences with intrusive thoughts, given participants largely followed directions, and non-completion did not appear to substantively influence the pattern of results. By replicating several lab-based findings, this study shows continuity between the offline and online versions of the paradigm. Given this continuity, researchers can avail themselves of several advantages the web provides for intrusive thoughts research. First, participants can be reluctant to report their experiences with common intrusive thoughts that often concern themes of sex, violence, and immorality (Rachman, 1997), and this may be especially true in the presence of an experimenter. The extra layer of anonymity in web studies, with no experimenter ever present, may allow more ecologically valid responding. Second, the recruitment of older adults into studies tends to be challenging, particularly in less densely populated areas. The web offers access to a wider pool of older adults (and other age groups), and may be used to target specific subgroups of interest. This access is improving due to the narrowing of the 'digital divide' between different age groups, with recent survey data indicating that over 85% of U.S. adults aged 50–64, and 58% of adults aged 65 and older, use the Internet (Pew Internet & American Life Project, 2012).

Limitations and Conclusion

While age trajectories were estimated across the adult lifespan, age was nonetheless confounded with cohort given the cross-sectional design. Similarly, the inter-individual

comparisons used in this study may not reflect the intra-individual changes in experiences with intrusive thoughts across the lifespan. Longitudinal studies of experiences with intrusive thoughts among non-clinical and clinical samples, as well as intensive intra-individual measurement designs (e.g., Brose et al., 2011) sampling both experimenter-provided and naturalist thoughts, are needed to verify the developmental changes suggested by our findings. In terms of measurement, multiple methods would be useful in future work to tease apart constructs such as the recurrence of intrusive thoughts and suppression effort and link them to possible mechanisms like executive functioning. Additionally, the current conceptualization of intrusive thinking across the lifespan could be productively integrated with the literature discussing the emotional and cognitive properties of intrusive thoughts ranging from non-clinical to clinical samples (e.g., Watkins, 2008). Finally, while the web provided advantages in recruiting participants and allowed greater anonymity in completing the intrusive thoughts thinking periods, the environment in which participants completed the task was not controlled. It is possible that participants' experiences of intrusive thoughts were influenced idiosyncratically by environmental distractions, or other uncontrolled factors. However, after conducting multiple checks to ensure the validity of the relationships (e.g., rerunning analyses excluding individuals with unusually fast responding, or those who did not write the intrusive thought in the instructed way), we have no reason to suspect that such factors played an important role in our results.

Notwithstanding these limitations, the current study highlights the importance of examining experiences with intrusive thoughts across the full adult lifespan. It appears that affective experiences during engagement with an intrusive thought showed gradual, linear trajectories across the adult age range, consistent with hypothesized changes in emotional functioning thought to underlie these experiences, but there was minimal evidence for age-related changes in difficulty controlling intrusive thoughts, suggesting a divide in aging effects linked to emotional versus cognitive outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1A

Figure 1B

Figure 1C

Figure 1D

Figure 1E

Figure 1F

Figure 1.

Figures 1A–1F. Mean positive affect, negative affect, suppression effort, perceived difficulty, frequency, and duration according to age group. BL refers to baseline, P1 refers to the first thinking period, and P2 refers to the second thinking period. The dotted lines connect each thinking period between age groups (e.g., connecting the first thinking periods for age 18–24 and age 25–34, etc.), while the solid lines show changes within each age group from the first to second period (e.g., connecting the first thinking period for age 18–24 to the second thinking period for age 18–24, etc.). Error bars represent the standard error within a particular age group.

Table 1

Descriptive Statistics for Sample Demographics by Age Group

	Age Group						
	18-24	25-34	35-44	45-54	55-64	65+	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Sex (Female)	165 (67)	202 (72)	155 (64)	182 (70)	222 (70)	50 (64)	976 (68)
Race*							
White ^a	184 (75)	219 (78)	187 (77)	207 (80)	251 (82)	68 (90)	1116 (79)
Black ^a	18 (7)	29 (10)	27 (11)	24 (9)	37 (12)	2 (3)	138 (10)
Other ^b	43 (18)	32 (11)	28 (12)	28 (11)	20 (7)	6 (8)	157 (11)
Ethnicity*							
Hispanic ^a	26 (12)	27 (10)	15 (7)	13 (5)	10 (3)	1 (2)	92 (7)
Non-Hisp. ^b	175 (80)	226 (84)	190 (86)	221 (90)	266 (91)	62 (94)	1141 (87)
Unknown ^{ab}	18 (8)	15 (6)	16 (7)	12 (5)	18 (6)	3 (5)	66 (6)
Total	245	280	245	262	317	78	1428

Note: Omnibus tests revealed associations between age and race or ethnicity at $p < .01$ or less. Age differences between race and ethnicity categories are noted by unique letter superscripts (i.e., 'a' versus 'b') and are all significant at $p < .01$. The percentages for race and ethnicity do not sum to 100% for some age groups due to rounding.

Table 2

Multilevel Models Examining Positive and Negative Affect

	<u>Positive Affect</u>	<u>Negative Affect</u>
	<u>Estimate (SE)</u>	<u>Estimate (SE)</u>
Fixed Effects		
Intercept	27.34* (.31)	2.73* (.01)
Time	-2.06* (.13)	.08* (.005)
Time^2	.38* (.03)	-.07* (.004)
Age	1.32* (.20)	-.05* (.009)
Instructions	.76 (.43)	-.003 (.02)
Age X Time	.36* (.08)	-
Inst. X Time	.35 (.18)	-
Age X Inst.	.26 (.28)	.0005 (.02)
Age X Inst. X Time	.27 (.12)	-
Age X Time^2	-	-.009* (.003)
Inst. X Time^2	-	.004 (.006)
Age X Inst. X Time^2	-	-.001 (.004)
Variance Components		
Intercept	62.54* (2.48)	.10* (.004)
Slope	6.49* (.48)	.003* (.001)
Residual	10.31* (.39)	14.22* (.42)

Note:

* Indicates significance at $p < .01$ or less. "Inst." refers to thinking instructions, "Time" to linear time, and "Time^2" to quadratic time. Negative affect, which was examined with a generalized multilevel model that used a log link function, is presented in log units. Thinking instructions were coded as suppression=1, monitoring=0, so that thinking instruction coefficients correspond to changes in the dependent variable for suppression instructions in comparison to monitoring instructions.

Table 3

Generalized Estimating Equations for Measures of Attempted Control Over Intrusive Thoughts

	Suppression Effort				Perceived Difficulty				Frequency				Duration					
	b	(SE)	Wald χ^2	OR	(99% CI)	b	(SE)	Wald χ^2	OR	(99% CI)	b	(SE)	Wald χ^2	OR	(99% CI)	OR	(99% CI)	
Intercept/Threshold	2.74*	(.05)	2826.95	15.42	(13.51–17.61)	2.30*	(.06)	1340.63	9.93	(8.45–11.67)	1.13	(.05)	436.31	3.10	(2.69–3.56)	–.12*	.89	(.80–1.00)
Period	.16*	(.05)	169.18	1.17	(1.03–1.33)	.41*	(.06)	168.63	1.51	(1.28–1.78)	.28*	(.05)	66.28	1.32	(1.17–1.49)	.03	1.03	(.94–1.13)
Instructions	.09*	(.07)	37.32	1.10	(.91–1.32)	–.004	(.09)	4.01	1.00	(.80–1.25)	.03	(.10)	.64	1.03	(.81–1.32)	–.17*	.84	(.72–.98)
Age	.07*	(.03)	17.98	1.07	(.99–1.17)	–.03	(.03)	2.87	.97	(.90–1.04)	–.002	(.04)	4.32	1.00	(.90–1.10)	–.04	.96	(.90–1.03)
Per. X Inst.	.56*	(.07)	68.67	1.75	(1.47–2.08)	.32*	(.09)	13.49	1.38	(1.10–1.74)	.05	(.07)	.47	1.05	(.87–1.28)	–.09	.91	(.79–1.06)
Per. X Age	–.03	(.03)	4.69	.97	(.89–1.06)	–.01	(.03)	.86	.99	(.92–1.06)	–.04	(.02)	1.83	.97	(.91–1.03)	.01	1.01	(.96–1.07)
Inst. X Age	.08	(.05)	2.33	1.08	(.96–1.21)	.02	(.04)	.17	1.02	(.92–1.13)	–.05	(.05)	1.15	.95	(.83–1.08)	–.03	.97	(.88–1.08)
Per. X Inst. X Age	–.03	(.04)	.56	.97	(.87–1.08)	–.01	(.04)	.06	.99	(.90–1.10)	.02	(.04)	.29	1.02	(.93–1.12)	.03	1.03	(.94–1.12)
Age^2	-	-	-	-	-	.03	(.02)	.26	1.03	(.99–1.08)	-	-	-	-	-	-	-	-
Per. X Age^2	-	-	-	-	-	–.05*	(.02)	10.26	.95	(.91–1.00)	-	-	-	-	-	-	-	-
Inst. X Age^2	-	-	-	-	-	–.04	(.02)	1.88	.96	(.91–1.03)	-	-	-	-	-	-	-	-
Per. X Inst. X Age^2	-	-	-	-	-	.01	(.03)	.22	1.01	(.95–1.08)	-	-	-	-	-	-	-	-

Note:

* Indicates significance at $p < .01$ or less. “Per.” refers to thinking period, “Inst.” to thinking instruction, “Age” to linear age, and “Age^2” to quadratic age. Intercepts are listed except for duration, which lists the threshold values for the lowest and middle duration categories found in the multinomial ordinal model. Because quadratic age effects were not hypothesized, quadratic terms were dropped due to non-significance from all models except perceived difficulty.