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It Gets Better with Time: Enhancement of Age-Related Positivity Effect in the Six Months Following a Highly Negative Public Event

Jaclyn H. Ford[1], **Haley D. DiBiase**[1], **Ehri Ryu**[1], and **Elizabeth A. Kensinger**[1]

[1]Department of Psychology, Boston College

Abstract

Age is associated with shifts toward more positive memory retrieval. The current study examined these shifts following a negative public event. Participants completed two surveys examining emotional responses to the 2013 Boston Marathon bombings, one immediately following the attack and another six months later. Age was associated with different effects of time on how individuals reflected on this event. Time was associated with an increased focus on negative components in young adults, but a decreased focus in older adults. These findings reveal a role of time in age-related positivity effects.

Keywords

Emotion; Aging; Flashbulb Event; Positivity Effect; Reappraisal

Cognitive aging research often emphasizes age-related declines in cognitive functions, including those related to memory encoding and retrieval (e.g., Park et al., 2002). However there are some domains where older adults exhibit cognitive preservation or even improvements relative to young adults. One such domain is the retrieval of emotional memory: Not only do older adults often benefit from an emotional memory enhancement, where age-related impairments are reduced for retrieval of emotional relative to neutral events (e.g., Kensinger et al., 2002), but they also exhibit a *positivity effect* where this enhancement is greater for positive relative to negative items (see Reed & Carstensen, 2012). This positivity effect may lead to better retrieval of positive relative to negative information and increased ratings of positivity for personal events (e.g., Comblain et al., 2005; Dijkstra & Kaup, 2005; Gallo et al., 2011; Rubin & Schulkind, 1997; Singer, Rexhaj, & Baddeley, 2007; but see Schlagman et al., 2009). Recently, research has shown that this effect is reflected in young and older adults' retrieval of highly negative events from their past: Compared to young adults, older adults rate these negative events as more positive

Address correspondence to: Jaclyn Hennessey Ford, JaclynHFord@gmail.com, 617-312-4735, Department of Psychology, Boston College, McGuinn Hall, Rm 504B, Chestnut Hill, MA 02467.

The authors declare no conflicts of interest and have no financial disclosures. The Time 1 data included in the model here have previously been analyzed and published (Ford, DiBiase, & Kensinger, 2017) and presented at the 2016 meeting of the Psychonomics Society. A subset of the reported Time 2 data was presented at the 2014 Cognitive Aging Conference in Atlanta. Finally, analyses of unrelated questions from Survey 2 (specifically, data on prosocial behavior) are currently in press (Ford, Gaesser, DiBiase, Berro, Young, & Kensinger, *in press*). No other questions from either survey have been analyzed or reported elsewhere.

(Comblain et al., 2005), use more positive words in their descriptions of these events (Ford, DiGirolamo & Kensinger, 2016), and report a greater focus on the positive aspects of these events during retrieval (Ford, DiBiase, & Kensinger, 2017).

The increased focus on positive aspects of equally negative events suggests an enhanced ability of older adults to consider silver linings, a capability that may allow them to reframe negative memories as more positive over time. Indeed, there is some evidence to suggest that older adults are more adept at reappraising memories to become more positive over time: When asked to consider prior ratings of emotional affect, age is associated with a tendency to overestimate positive (e.g., Kennedy et al., 2004; Ready, Weinberger, & Jones, 2007) and underestimate negative reports (e.g., Levine & Bluck, 1992).

These studies revealed age-related shifts in evaluations of prior emotions, but it is unclear how the memories, themselves, change. It is possible that the tendency of older adults to focus on positive aspects (Ford et al., 2017) can lead to a selective strengthening of these details in their memory representation. In other words, time would have a differential effect on positive v. negative details in older adults, but not in young adults. Such an age-by-valence interaction on these shifts would lead to an exaggerated positivity effect over time. The current study tested this hypothesis by examining a recent highly negative public event that was experienced by both young and older adults. The use of a common emotional event ensured that the same amount of time had passed since the event and that the features of the event could be held as constant as possible across ages. In other words, examining age-related differences in emotional reactions to a public event can allow researchers to isolate cognitive processes affected by aging, controlling for the remoteness and content of the event.

The selected event was the 2013 bombings at the Boston Marathon. This event was of particular interest to our research question for multiple reasons. First, the Boston Marathon is a city-wide event that attracts individuals across the lifespan, ensuring that participants of all ages would have known about the bombings and felt directly affected by them. Second, the marathon bombings were inarguably a negative event for all participants. Prior work on age-related positivity enhancements over time has focused on shifts in emotional evaluation for either personal autobiographical content (e.g., Kennedy et al., 2004; Ready, Weinberger, & Jones, 2007) or for events that some participants considered positive and others considered negative (e.g., Levine & Bluck, 1992). The current study extended this work to examine older adults' ability to reappraise memories for events with immense public significance and negative valence.

Finally, for many of our participants, their highly negative memories for the bombings are tightly intertwined with their more positive memories of events that transpired over the following days: the heroes who rushed to help those in need, the resilience of the victims, and the coming together of the city of Boston to grow and heal. The presence of these positive elements made it possible to measure age-related changes to positive and negative aspects separately. The current analysis examined the shift in these elements from immediately following the bombings to a six-month follow-up, and evaluated the relation between these shifts and age. Based on prior research suggesting that older adults are more

motivated to reappraise negative emotions (e.g., Mather & Carstensen, 2005) and have superior regulation capabilities (Blanchard-Fields, 2007), we expected age-related positivity effects to be enhanced at the 6 month delay.

Methods

Participants

In order to collect immediate responses to the bombings, we contacted all individuals who had participated in prior studies and indicated they would like to be contacted about future studies; participants were mailed or e-mailed a survey 1–2 weeks after the Boston Marathon bombings occurred (Time 1, or T1). Participants who successfully completed the first survey (N= 267, M_{age}=54.82, SD=24.87, 19–85 years; M_{edu}=16.24, SD=2.41, 12–21 years; 177 female) were sent a follow-up survey six months later (Time 2, or T2). The 147 participants[1] who completed and returned this second survey (M_{age}=58.45, SD=24.44, 19–85 years; M_{edu}=16.38, SD=2.51, 12–21 years; 104 female) are reported in this analysis[2] . One participant (male, age=24, edu=16) did not provide focus ratings at T2 and a second (female, age=74, edu=18) did not include a rating of positive focus at T1; these participants were excluded from analyses examining shifts in focus ratings. Because this study took advantage of rapid data collection from as many participants as possible within a narrow time frame, we did not establish an a priori sample size; we included data from all participants who completed and returned their surveys within a month. Participants were compensated $20 ($10 per survey) for their participation and gave written informed consent in accordance with the requirements of the Institutional Review Board at Boston College.

Procedure & Materials

Two one-hour surveys [sent 1 week (T1) and 6 months (T2) after the bombings] asked participants about their memories for and emotional reactions to the Marathon bombings. We include the T2 survey in the appendix, with the questions used in the current analysis in *italics* (see Ford et al., 2017 for T1 survey). The first half of both surveys asked participants to think about their memory for events pertaining to the bombings and their aftermath. In the second half, participants were asked to report a non-marathon control event (e.g., a family emergency, party with friends, or Easter vacation) from the same timeframe as the bombings and with some import to the participant. Because a large number of participants (40%) did not report a control event at T2, data from these events were excluded from the analysis.

The current analysis focuses on participants' emotional reactions to the event and on how these reactions shift over time (i.e., from T1 to T2)[3] . These shifts were examined as a function of participant age to identify age-by-valence interactions in shifts for ratings and narrative content. In each survey we asked participants to rate the extent to which they

[1]This sample size can be considered "medium" (Kline, 2005) and is close to the proposed 10 observations/variable minimum (Nunnally, 1967), suggesting that it is likely acceptable but not ideal. The suitability of this sample size is further supported by the fact that the estimation converged with no problem.

[2]This subgroup of participants from Time 1 who also completed the Time 2 survey did not differ from those who did not complete the Time 2 survey in terms of education ($t(264)$= .90, p= .37) or gender ($\chi^2(1)$= 2.91, p=.09). However the subgroup that completed the Time 2 survey was significantly older than the subgroup that did not (M= 50.37, SD= 24.77; $t(265)$= 2.67, p=.008), due to greater attrition rate for young adults (52% attrition in participants ages 19–35) than for older adults (37% attrition in participants ages 75–85).

thought about the negative and the positive aspects of the events surrounding the Marathon bombings. Specifically, they were asked (on a scale of 1–7) how much they agreed with the following statements:

- When I think of the marathon bombing, I think about the negative aspects – the hurt and devastation caused
- When I think of the marathon bombing, I think about the positive aspects – the heroism and the way the city has come together

Due to prior findings from our lab showing that an individual's initial response to the Marathon bombings influenced their ratings of the positive and negative aspects at T1, and that these responses were related to participant age (Ford et al., 2017), we controlled for initial reaction variables in our analysis. In the initial survey (T1), participants rated (on a scale of 1–7) the a) emotional arousal, b) surprise, and c) overall significance attributed to the bombing. Further, to assess their degree of personal involvement, participants reported their own involvement in the 2013 Boston Marathon, their involvement in prior Boston Marathons, and any friend or family involvement in the 2013 Marathon. These responses were coded as follows:

- *Involvement in the 2013 Boston Marathon:* No involvement=0, Watched on television=1, Watched in person=2, Ran or volunteered=3
- *Prior involvement in Boston Marathons:* No prior involvement=0, Previously watched on TV=1, Previously watched in person=2, Previously watched from the finish line, ran, or volunteered=3
- *Friend/family running in/volunteering for the 2013 Boston Marathon:* No=0, Yes=1

Because the current analysis examines how emotional response to a public event change over time, it is important to consider factors that might reflect how individuals have interacted with the details of the event in the intervening period. In other words, if young and older adults are learning new details of the event from distinct sources, this could explain divergent effects of time. To this end, the six-month survey (T2) included a number of questions that were included to examine age differences in intervening news exposure. Participants were asked to report (on a scale of 1–7) the frequency with which they used social medial, television, radio, police scanners, or conversations with friends and family to obtain additional information about the bombings.

Data Analysis

A correlation matrix of these observed variables was generated from the data of all 147 participants (see supplementary materials) and entered into LISREL 9.30 (http://www.ssicentral.com/lisrel/index.html) and used to estimate the associations between age and shifts in positive and negative emotions in a Structural Equation Model (SEM). The

[3]The current manuscript examines the age-by-valence interaction in shifts in ratings of emotional focus. The same analysis was conducted looking at interactions for narrative content (See supplementary materials). Interestingly, although both measures exhibit a significant age-by-time-by-valence interaction, the structural equation models suggest that these interactions may be driven by different underlying processes. Future work is needed to investigate these differences.

measured dependent variables in this model were the self-report ratings of focus on positive and negative aspects at T1 and T2. The latent variable specification was manipulated so that (within each valence) two latent variables perfectly replicated the observed score at T1 (i.e., baseline) and the observed change between the two time points (i.e., change; see Kievit et al., *in press* for description of Latent Change Score models). By assigning a loading of 1 onto the baseline latent variable for both measures and a loading of 1 for the Time 2 measure with no residual, the two latent variables are set up so that:

Observed rating at T1 = 1*Baseline + 0*Change (with no residual)

Observed rating at T2 = 1*Baseline + 1*Change (with no residual)

Because they were set up with no residual error, simplifying these equations become:

Baseline = Observed rating at T1

Change = Observed rating at T2 – Observed rating at T1

Age at the time of the initial survey (measured continuously) was included as an observed independent variable of interest. The effects of age on all four dependent latent variables were estimated in the SEM. We controlled for six observed initial experience variables from T1—emotional arousal, personal significance, 2013 self-involvement, prior self-involvement, 2013 friend/family involvement, and surprise. Based on our prior work using the T1 data (Ford, DiBiase, & Kensinger, 2017), surprise was included as an observed variable and the other observed initial experience variables loaded onto two latent independent variables using Principal Components Analysis: Emotional Importance (arousal and significance) and Involvement (2013 involvement, prior involvement, and friend/family involvement). In this prior model, ratings of surprise were not related to age (see also correlation matrix in Supplementary Materials) and were not uniquely predictive of ratings of focus on positive aspects (i.e., when controlling for Emotional Importance and Involvement, this pathway was insignificant (Ford et al., 2017). Therefore, these paths were not estimated in the current model (Figure 1).[4]

Four intervening experience variables from T2 measuring news exposure from television, radio, social media, and discussions with family and friends were included in the SEM[5] . These four variables were entered into a Principal Components Analysis (PCA; See Supplementary Materials) using a Promax rotation with Kaiser normalization. This PCA produced two factors: Traditional Media (Radio and Television) and Social Media (Social Media and Discussions with Friends and Family). Paths were estimated examining the associations between Age and these two latent variables, as well as the effects of Traditional and Social Media exposure on the change in positive and negative ratings over time.

Results

Means and standard deviations for all observed variables are presented in the Table. The hypothesized structural equation model was estimated using LISREL 9.3 (See Figure 1 for

[4]Adding these paths into the model did not significantly improve model fit. Therefore, the more parsimonious model was retained.
[5]We also asked participants to report news exposure from police scanners, but this variable was not included in the model because over 90% of participants reported never or rarely obtaining news from this source.

estimated model with standardized estimates of significant paths reported, $\alpha = .05$). The estimated model fit the data fairly well, with an RMSEA=.05 [see MacCallum, Browne, & Sugawara, 1996; χ^2 (75, N=147) = 100.33, p=.03; Comparative Fit Index (CFI)= .93; Standardized RMR= .08]. Path estimates related to initial experience variables (i.e., emotional importance, involvement, and surprise) replicated prior findings from this dataset (Ford et al., 2017). Age was positively associated with emotional importance (φ_{14}=.30), and negatively associated with involvement (φ_{24}= −.46). Age was related to increased estimates of positive baseline ratings (Υ_{14}=.24), but did not have a significant relationship with baseline negative ratings (Υ_{24}=.15). Surprise was positively associated with emotional importance (φ_{13}=.23), and with involvement (φ_{23}=.33). Emotional importance was related to increased estimates of positive (Υ_{11}=.26) and negative (Υ_{21}=.46) baseline ratings. Involvement was positively related to baseline positive ratings (Υ_{12}=.36) and negatively related to baseline negative ratings (Υ_{22}= −.27). Surprise had a positive relationship with baseline negative ratings (Υ_{23}=.23).

Not surprisingly, age was associated with increased estimates of traditional media exposure (φ_{54}=.53) and decreased estimates of social media exposure (φ_{64}= −.61). Neither estimate of media exposure was related to estimates of change for positive emotion ratings (Υ_{35}= .08 and Υ_{36}= −.03 for traditional and social media, respectively). Estimates of traditional media exposure were positively related to estimates of change in negative emotion ratings (Υ_{45}= .26), while estimates of social media exposure were negatively related to these estimates (Υ_{46}= −.25).

The key result was that there was a significant negative relation between age and estimates of change in ratings of negative emotion from T1 to T2 (Υ_{44}= −.38). Age was not associated with any change in ratings of positive emotion (Υ_{34}= .03; see Figure 2). To follow-up on the effect of age on change in ratings of negative aspects, we examined the estimated conditional mean of negative change at one standard deviation above the mean age (82.29 years old) and one standard deviation below the mean age (34.01 years old)[6] . At one standard deviation below the mean age (i.e., “young adults”), the estimated change in ratings of negative aspects was 0.62 (i.e., *increase* in ratings of negative aspects over time). Conversely, at one standard deviation above the mean age (i.e., “older adults”), the estimated change in ratings of negative aspects was −0.78 (i.e., *decrease* in ratings of negative aspects over time).

To test whether this age-by-valence interaction in change over time was significant, we compared the model reported above to a second model in which the effects of age on the two change variables were constrained to be equal. This simplified model had significantly worse fit than our original model (χ^2_{diff} (1, N=147) = 5.1, p=.02), revealing that the original model should be retained and that the underlying data are consistent with an age-by-valence interaction.

[6]The model was identified so that the estimated conditional means (i.e., intercepts) of the latent change variables were set to zero at the mean age. The estimated conditional means of change at one standard deviation above and below the mean represent the extent of the changes relative to the means (that were set to zero) in standardized metric.

Discussion

The positivity effect is defined by an age-by-valence interaction, where age is associated with retrieval of relatively more positive than negative information when compared to young adults (Reed & Carstensen, 2012). This interaction can be driven by either an increased age-related focus on positive content or by a decreased age-related focus on negative content. It is notable that the current data suggest that *both* of these patterns may contribute to an overall positivity effect, but they may have different time courses. Immediately following a highly negative event, older adults were more likely than young adults to report focusing on the *positive* aspects, with no significant effects on negative aspects. However, there was a significant difference in how time affected the way young and older adults process negative information: Time (i.e., the change from T1 to T2) was associated with an increased focus on negative components in young adults, but a decreased focus on negative components in older adults. In other words, although older age is associated with more positive emotion experience at the time of the event, the current study suggests that an additional negativity-decreasing effect may cause age-by-valence interactions to increase over time.

Age-related reversals in how time alters negative aspect focus are consistent with theories stating that age can influence motivation and priorities (e.g., Carstensen, Isaacowitz, & Charles, 1999). According to these theories, young adults are motivated to acquire knowledge and new information in an effort to plan for the future. It has been argued that focusing on the negative might actually be adaptive for such goals, as it can be easier to learn from the bad than from the good (i.e., “bad is stronger than good”, Baumeister et al., 2001). For individuals who prioritize the acquisition of knowledge, such as young adults, negative details may be selectively reinforced and become more accessible over time, leading to increased focus on these details over time. Notably, although negative content is preserved over time, previous research has shown that negative affect fades more quickly than positive affect (Walker et al., 1997). Future work will be needed to determine how reported “focus” on negative v. positive aspects corresponds to the re-experiencing of affect.

Motivational shifts may also explain why, unlike young adults, older adults exhibit temporal *decreases* in their reports of focusing on the negative aspects of the bombings. While young adults prioritize the acquisition of new information to help prepare for future events, older adults prioritize social and emotional goals (e.g., Carstensen, Isaacowitz, & Charles, 1999), Therefore, older adults may focus more on positive information immediately following the event (Mather & Carstensen, 2005), and would not be as motivated to attend to, elaborate on, or reinforce negative details as young adults are.

Although age-related motivational shifts can explain these findings, it can be difficult to confirm their role because of the correlational and self-report nature of the current study. Young and older adults differ in many ways other than their age, so there are several other potential explanations for why we may see age-related differences across the six-month window. For example, young and older adults may differ in how they initially experienced the event and in how they learned about information in the intervening months. In an effort to control for some of these differences, the current model included several self-report ratings and examined their individual effects. We see age effects above and beyond these

control variables, suggesting that initial or intervening experiences are not driving the age differences. In other words, these findings are consistent with a persisting age-related effect, such as the motivations shifts detailed above. However, we cannot rule out the influence of non-measured factors nor eliminate the possibility that the self-reported factors were not measured with sufficient precision.

In the current study, the effects of time on memory representations were subject to an age-by-valence interaction where older adults' memory representations become less negative over time while young adults' memories become more negative. Critically, we show that age differences previously reported in laboratory settings can extend to tragic events of high public significance. The differential effect of time on young and older adults' memories leads to an exaggerated positivity effect over time and may contribute to older adult's ability to look at and emphasize the silver linings of a negative event.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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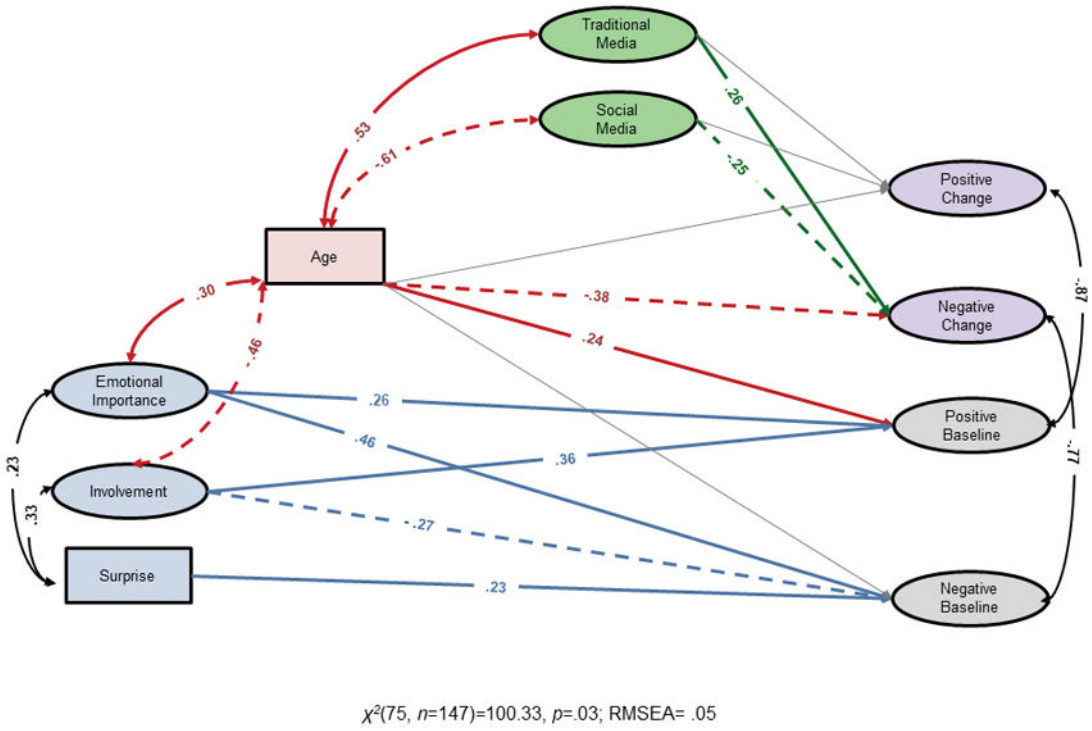

Figure 1.

Visual representation of model examining effects of age, emotional importance, involvement, surprise, traditional media use, and social media use on reported baseline measures of focus on positive and negative aspects of the bombings (gray ovals) and on the change in these measures from Time 1 to Time 2 (purple ovals). Red= Significant effects of age; Blue= Significant effects of initial experience variables; Green= Significant effects of intervening variables; Black= Significant covariance among initial experience variables; Gray= Non-significant paths that were included in the model. Solid lines depict positive effects while dotted lines depict negative effects. Ovals = Latent Variables; Rectangles = Observed Variables. Values represent standardized model estimates of each significant effect.

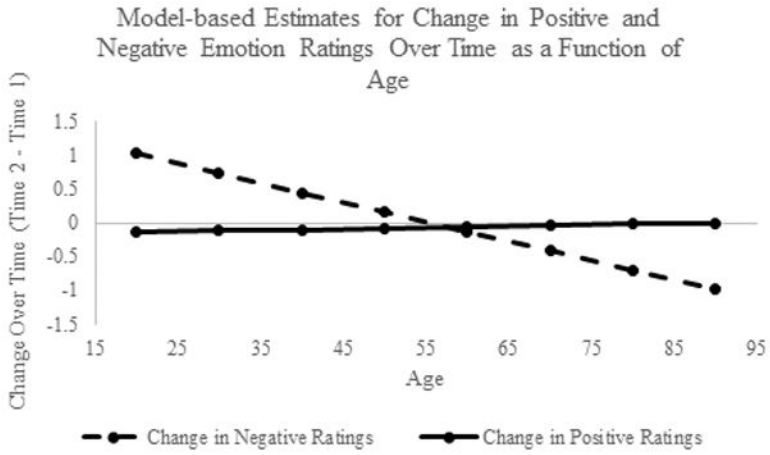

Figure 2.

Model-based estimates of change in positive (solid line) and negative (dashed line) emotion ratings over time as a function of age. The model was identified so that the estimated conditional means (i.e., intercepts) of the latent change variables were set to zero at the mean age. The estimated conditional means of change at one standard deviation above and below the mean represent the extent of the changes relative to the means (that were set to zero) in standardized metric.

Table

Descriptive Statistics for all observed variables

	Mean	Standard Deviation	Minimum	Maximum
Age	58.45	24.44	19	85
Emotional Arousal *(1–7 Scale)*	5.73	1.32	1	7
Personal Significance *(1–7 Scale)*	4.99	1.74	1	7
This Year Self Involvement *(0=None, 1=Watched TV, 2=Watched in person, 3=Ran or volunteered)*	0.75	0.83	0	3
Prior Self Involvement *(0=None, 1=Watched TV, 2=Watched in Person, 3=Watched from finish line, Ran, or Volunteered)*	1.79	0.87	0	3
This Year Friend/Family Involvement *(0=No, 1=Yes)*	0.34	0.47	0	1
Surprise *(1–7 Scale)*	6.34	1.42	1	7
Focus on Negative Aspects *(1–7 Scale)*				
Time 1	5.97	1.34	1	7
Time 2	5.89	1.38	1	7
Difference	−.08	1.43	−5	5
Focus on Positive Aspects *(1–7 Scale)*				
Time 1	5.39	1.64	1	7
Time 2	5.33	1.74	1	7
Difference	−.06	1.43	−6	6