The Role of Dispositional Reappraisal in the Age-Related Positivity Effect

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Objectives. This study aimed to clarify mixed findings about whether older adults have a cognitive bias toward positive and/or away from negative information (the positivity effect) by examining whether dispositional cognitive reappraisal (a disposition to reinterpret an event to lessen its negative emotional impact) could moderate this effect.

Methods. Participants from 19 to 79 years old watched a video that simultaneously showed a positive and a negative image. Two layers of their emotion regulation process, attention (measured by percent fixation duration) and cognitive effort (measured by pupil dilation), toward each image were recorded. One dispositional emotion regulation strategy, dispositional cognitive reappraisal, was also assessed.

Results. In general, older age was related to less percent fixation duration but not to differential pupil dilation toward the negative image. However, among those with higher dispositional cognitive reappraisal, older age was related to smaller pupil dilation for the negative image.

Discussion. Findings suggest that whether the age-related positivity effect occurs depends on the matching between cognitive processes and dispositional emotion regulation strategies.

Key Words: Emotion regulation—Eye tracking—Fixation duration—Positivity effect—Pupil dilation—Reappraisal.

OLDER adults’ cognitive bias toward positive and away from negative stimuli relative to younger adults is termed “the positivity effect” (for a review, see Mather & Carstensen, 2005). Evidence for the positivity effect has been found in attention (Mather & Carstensen, 2003), memory (Charles, Mather, & Carstensen, 2003), and neural activity (Mather et al., 2004). However, other studies have not found the positivity effect (Fung et al., 2008; Grühn, Smith, & Baltes, 2005). Murphy and Isaacowitz (2008) conducted a meta-analysis and found that both younger and older adults showed a cognitive bias for both positive and negative stimuli over neutral stimuli. The current study aimed to address these inconsistent findings by examining the positivity effect in different layers of the emotion regulation process.

There is theoretical as well as some empirical support for the relationship between the positivity effect and the emotion regulation process. Socioemotional selectivity theory (Carstensen, 2006) suggests that the positivity effect can be viewed as a cluster of emotion regulation activities that help older adults to maintain or even improve subjective well-being in later adulthood. Indeed, Isaacowitz, Toner, Goren, and Wilson (2008) have empirically shown that older adults in negative mood looked toward positive and away from negative faces, probably as a way to regulate emotion.

As a cluster of emotion regulation activities, the positivity effect may be understood in terms of models of emotion regulation. In this study, we aimed at shedding light on the controversy surrounding the positivity effect by examining the effect in terms of Gross’s (1998) emotion regulation model. The model makes two predictions: First, Gross and John (2003) suggest that there are individual differences in the disposition to use emotion regulatory strategies. One such strategy is cognitive reappraisal, which involves reinterpreting an event to make its emotional impact less negative. We hypothesized that individual differences in dispositional cognitive reappraisal would moderate the positivity effect, such that those with higher dispositional reappraisal level would show an exaggerated positivity effect in relevant cognitive processes. Second, Gross’s model proposes multiple layers of the emotion regulation process. One layer regulates the attention toward various stimuli (i.e., the attention control stage), which happens early in the emotion regulation process. Another layer regulates the cognitive effort allocated to various stimuli (i.e., the cognitive change stage), which happens later in the emotion regulation process. In this study, we measured the two layers of emotion regulation processes simultaneously by assessing fixation duration and pupil dilation using the eye-tracking technique. Fixation duration was used in most previous eye-tracking studies on the positivity effect (e.g., Isaacowitz, Wadlinger, Goren, & Wilson, 2006). Longer fixation duration indicates more attention to the stimuli. In contrast, pupil dilation is positively correlated with both rumination about emotional information (Steinhauer, Carter, Ramel, Thase, & Siegle, 2003) and emotional arousal (Partala & Surakka, 2003). Larger pupil dilation indicates more cognitive effort employed to process the stimuli and/or higher emotional arousal caused by the stimuli. Recently, Allard, Wadlinger,
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and Isaacowitz (2010) have reanalyzed eye-tracking data obtained in a prior study (Isaacowitz et al., 2008). Although the prior study found that older people showed preferences toward positive stimuli in terms of fixation duration, Allard and colleagues (2010) did not find the same positive preferences in terms of pupil dilation. Their results confirm our argument that fixation duration and pupil dilation measure different layers of the emotion regulation process.

The goal of this study was to examine whether dispositional reappraisal acts as a moderator in the emotional regulation process. As reappraisal is a typical emotion regulation strategy in the cognitive change stage of the emotion regulation process (Gross & John, 2003), it should happen after the change of attention (measured by fixation duration) but before or during the change of cognitive effort and emotional arousal (measured by pupil dilation). Thus, the dispositional use of reappraisal should have a greater influence on pupil dilation, which indicates processes during or after reappraisal, than on fixation duration, which indicates processes before reappraisal. Our hypothesis is that dispositional reappraisal moderates the positivity effect in pupil dilation, with those of higher dispositional reappraisal more likely to show the positivity effect than those of lower dispositional reappraisal. However, dispositional reappraisal should have a lesser moderating role in the positivity effect in fixation duration.

METHODS

Participants

One hundred and five adults from Hong Kong, China, participated in this study. They were offered either monetary stipend or course credit for their participation. Nineteen adults failed to generate complete eye-tracking data because of reflective eyewear or obfuscation of the pupil, leaving 86 participants (37 females; \( M_{\text{age}} = 46.58 \) years, \( SD_{\text{age}} = 20.81 \) years; age range = 19–79 years) for full analysis.

Stimuli

A 14-s government public announcement clip was used as the stimulus. Two images of the same man appeared on each side of the screen, discussing the positive and negative aspects of aging. The two images took turns speaking, whereas the background remained unchanged. The left one (negative image) showed negative information about aging, whereas the right one (positive image) showed positive information.

Measures and Procedure

Visual abilities.—Visual abilities were assessed by the Snellen Visual Acuity test, the Pelli–Robson Contrast Sensitivity test (Pelli, Robson, & Wilkins, 1988), and a screen visual acuity test before the eye-tracking experiment.

Eye-tracking procedure.—We used the Applied Science Laboratories Eye-Tracker Model 504 in the current study. A 17-point calibration was completed before the formal recording. Participants were asked to look at the screen naturally as if they were watching TV at home. Then the video was played twice on the screen (two trials). As the results below did not differ by trial, the average of the two trials was used in the analyses.

Two series of areas of interest (AOIs) were set for the eye tracker across the viewing time, one was on the negative image and the other was on the positive image. The two series of AOIs were always paired with each other. The duration of each pair of AOIs depended on the length of each sentence the two images spoke. Once the speaker switched, the current pair of AOIs ended and a new pair began.

Percent fixation duration.—Because the speaking image obviously attracted most attention, there was little variance in fixation to one image while it was speaking. Thus, we constructed the index “negative fixation” as the total percent fixation duration toward the negative image when the positive image was speaking. Percent fixation duration was calculated by dividing the raw fixation time in the target AOIs by the total fixation time in the complete video. We constructed the index “positive fixation” (i.e., the total percent fixation duration toward the positive image when the negative image was speaking) by the same method.

Pupil dilation.—To control for individual differences in pupil size, raw pupil dilation scores were adjusted by the range of pupil dilation within each participant, that is, \( (\text{current pupil diameter} - \text{minimal pupil diameter})/\text{maximal pupil diameter} - \text{minimal pupil diameter} \). This formula has been successfully used in previous studies (e.g., Allard et al., 2010). The “negative pupil dilation” index was calculated as the mean of the range-adjusted pupil dilation in all negative AOIs when the positive image was speaking. The “positive pupil dilation” index was created by the same method.

Manipulation check.—After watching the video, participants rated the positivity and negativity of the two images respectively on a 7-point scale. They also rated whether the two images brought them three positive (i.e., excited, happy, and peaceful) and three negative (i.e., fearful, sad, and dull) emotions on a 7-point scale.

Reappraisal.—Individual differences in dispositional reappraisal were then measured by the Cognitive Reappraisal scale of the Emotion Regulation Questionnaire (Gross & John, 2003). The scale includes six 7-point items measuring reappraisal (Cronbach’s \( \alpha = .71 \)), such as the extent to which a respondent controls emotions by changing the way he/she thinks about the situation. The test–retest reliability of the scale across 3 months is .69 (Gross & John, 2003).
Finally, potential covariates were measured. Cognitive abilities were assessed by forward and backward digit span test, digit symbol substitution test (Wechsler, 1981), Mini-Mental State Examination (Folstein, Folstein, & Mchugh, 1975), and backward counting task (counting backward from 100 to 1 within 30 s; Tun & Lachman, 2005). Demographic information, including age (in years), sex, and years of education, was also recorded. Self-reported health status was assessed by the Physical Health Inventory (Wahler, 1983; Cronbach’s α = .87). The pattern of results reported subsequently did not change after statistically controlling for these potential covariates.

**RESULTS**

Descriptive statistics and intercorrelations of the main variables are shown in Table 1.

### Manipulation Check

As expected, participants rated the negative image to be less positive (M = 1.663, SD = 1.001) than the positive image (M = 6.512, SD = 0.699), t(85) = −33.733, p < .001, and more negative (M = 6.153, SD = 1.107) than the positive image (M = 1.412, SD = 0.955), t(84) = 28.166, p < .001. Moreover, the negative image led to less positive emotions (M = 1.709, SD = 0.870) than did the positive image (M = 5.105, SD = 1.522), t(85) = −19.305, p < .001, and more negative emotions (M = 3.861, SD = 1.797) than did the positive image (M = 1.574, SD = 0.819), t(85) = 10.748, p < .001.

### The Positivity Effect as Measured by Pupil Dilation

Negative and positive fixation indices were regressed on standardized age, standardized reappraisal score, and their interaction using multiple regression analysis. For negative fixation, the regression model was significant, F(3, 82) = 4.701, p = .004, R² = .147. The main effect of age was significant, B = −1.416, p = .005, indicating that older age was related to relatively less fixation toward the negative image. Neither the main effect of reappraisal, B = −0.898, nor the Age × Reappraisal interaction, B = 0.748, was significant. For positive fixation, the regression model was nonsignificant, F(3, 82) = 0.265, and all coefficients were nonsignificant.

### The Positivity Effect as Measured by Fixation Duration

Negative and positive fixation indices were regressed on standardized age, standardized reappraisal score, and their interaction using multiple regression analysis. For negative fixation, the regression model was significant, F(3, 82) = 4.701, p = .004, R² = .147. The main effect of age was significant, B = −1.416, p = .005, indicating that older age was related to relatively less fixation toward the negative image. Neither the main effect of reappraisal, B = −0.898, nor the Age × Reappraisal interaction, B = 0.748, was significant. For positive fixation, the regression model was nonsignificant, F(3, 82) = 0.265, and all coefficients were nonsignificant.

### Table 1. Means, standard deviations, and zero-order correlations of the main variables (N = 86)

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<td>Education</td>
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<td>3. Forward digit span</td>
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<td>4. Backward digit span</td>
<td>−.703**</td>
<td>.693**</td>
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<td>5. Digit symbol substitution test</td>
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<td>.510**</td>
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<td>6. Mini-Mental State Examination</td>
<td>−.514**</td>
<td>.538**</td>
<td>.367**</td>
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<td>7. Backward counting</td>
<td>−.644**</td>
<td>−.599**</td>
<td>−.423**</td>
<td>−.563**</td>
<td>−.749**</td>
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<td>8. Visual acuitya</td>
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<td>−.169</td>
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<td>−.461**</td>
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<td>10. Physical health</td>
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<td>.041</td>
<td>.113</td>
<td>.190</td>
<td>.204</td>
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<td>.243*</td>
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<td>.153</td>
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<td>−.273*</td>
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<td>12. Negative percent fixation duration</td>
<td>−3.033**</td>
<td>−.252**</td>
<td>−.176</td>
<td>.310**</td>
<td>.324**</td>
<td>.216*</td>
<td>−.304**</td>
<td>−.136</td>
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<td>13. Positive percent fixation duration</td>
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<td>.025</td>
<td>−.082</td>
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<td>.053</td>
<td>−.101</td>
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<td>14. Negative pupil dilation</td>
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<td>.069</td>
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<td>SD</td>
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<td>0.742</td>
<td>4.791</td>
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*aAll participants obtained full marks in the screen visual acuity test, thus the score of that test was not included in the table.

bMeasured by the Snellen Visual Acuity Test. The original ratio scores were recoded according to the following rule: 20/16 = 1, 20/20 = 2, 20/25 = 3, 20/32 = 4, 20/40 = 5, 20/50 = 6, 20/63 = 7, 20/80 = 8, 20/100 = 9, 20/125 = 10, and 20/160 = 11.

*Measured by the Pelli–Robson Contrast Sensitivity Test.

*p < .05; **p < .01.
**DISCUSSION**

This study aimed at testing whether the occurrence of the positivity effect depended on the matching between cognitive processes and dispositional emotion regulation strategies. Our findings that a main effect of age was found in fixation but not in pupil dilation toward negative image replicated previous findings in the mainstream American literature (Allard et al., 2010; Isaacowitz et al., 2006), suggesting that our methodology is valid. This finding also supports our argument that fixation duration and pupil dilation measure two distinct layers of the emotion regulation process. Compared with younger adults, older adults fixate on the negative image less (layer one) but as a group maintain the cognitive effort and/or emotional arousal toward the negative image (layer two). Distinguishing the two layers of emotion regulation process provides a new perspective to account for the mixed findings on the positivity effect (e.g., Grühn et al., 2005; Mather & Carstensen, 2003; Murphy & Isaacowitz, 2008). It is possible that different studies assessed the positivity effect in different layers of emotion regulation process and thus came to contradictory results.

More importantly, we found that dispositional emotion regulation strategies (e.g., reappraisal in the current study) moderated the positivity effect but only in the temporally relevant layer of emotion regulation process. Previous studies have found different patterns of positivity effect using measurements of different cognitive processes. For example, Schlagman, Kliegel, Schulz, and Ksavirashvili (2009) found the positivity effect in voluntary autobiographical memory but not in involuntary autobiographical memory. Older adults in Kensinger’s (2008) study only showed a bias in memorizing nonarousing positive words but not in memorizing arousing positive words. Other studies have identified dispositional tendencies such as interdependent self-construal (Fung, Isaacowitz, Lu, & Li, 2010) as moderators of the positivity effect. As far as we know, this is the first study investigating the interaction between different cognitive processes and dispositional tendencies. We found that only among people with a higher reappraisal level did older adults show less cognitive effort and/or emotional arousal toward the negative image compared with younger adults. Reappraisal is mainly about evaluating the importance or relevance of the attended information (Gross, 1998). For older people with a higher reappraisal level, they can judge the negative image to be unimportant and thus allocate less effort toward it. However, this reduction of cognitive effort and/or emotional arousal does not appear for people with a lower level of dispositional reappraisal. These findings suggest that the positivity effect may be more likely to occur in the emotion regulation activities that are matched with the individuals’ dispositional strategies.

We also found that only fixation and pupil dilation toward the negative image varied with age but not those toward the positive image. This is consistent with the negative dominance principle reviewed by Baumeister, Bratslavsky, Finkenauer, and Vohs (2001). Negative information and the regulation of negative emotions are more critical for human survival from the evolutionary perspective and thus may be more likely to give rise to age differences in attention. Moreover, the images we used are about aging. It may be the case that negative images of aging are more likely to result in age differences in attention than are positive images of aging. Future studies should address these potential biases.

Another limitation is that the left/right position was confounded with the emotional valence of the two images in the current study. However, the position of the images should have similar impacts for people of different ages and should not influence the pattern of the age-related positivity effect or the moderating role of reappraisal. A final limitation is that we measured reappraisal as a dispositional trait and did not directly assess the emotion regulation process while the participants were watching the video. Future studies can include some real-time measures of emotion regulation or use explicit reappraisal instructions.

Despite these limitations, findings from this study help to clarify the mixed findings on the age-related positivity effect (e.g., Grühn et al., 2005; Mather & Carstensen, 2003). The pattern of positivity effect is different in different layers of the emotion regulation process. Older people in general shorten the time spent fixating on negative images, but only older adults with high dispositional reappraisal level reduce cognitive effort allocated to negative images. Future research about the positivity effect should take the interaction between layers of the emotion regulation process and dispositional emotion regulation strategies into consideration.
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