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## Linking Process and Outcome in the Study of Emotion and Aging

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### Abstract

Current theory and research on emotion and aging suggests that (1) older adults report more positive affective experience (more happiness) than younger adults; (2) older adults attend to and remember emotionally-valenced stimuli differently than younger adults (i.e., they show age-related positivity effects in attention and memory); and (3) the reason that older adults have more positive affective experience is because the positivity effects they display serve as emotion regulatory strategies. It is suggested that age differences in cognitive *processes* therefore lead to the *outcome* of positive affective experience. In this paper, we critically review the literature on age differences in positive affective experience and on age-related positivity effects in attention and memory. Furthermore, we question the extent to which existing evidence supports a link between age-related positivity effects and positive affective outcomes. We then provide a framework for formally testing process-outcome links that might explain affective outcomes across adulthood. It may be that older adults (and others) do sometimes use their cognition as a regulatory tool to help them feel good, but that can only be demonstrated by specifically linking cognitive processes, such as age-related positivity effects, with affective outcomes. These concepts have implications for cognition-emotion links at any age.

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A recent article claimed that “people get happier as they get older, and researchers are not sure why” (Bakalar, 2010, p. D5). Of course, various subdisciplines of psychology have already weighed in on different possible mechanisms that could lead individuals to experience more positive affective outcomes – more happiness – as they grow older, including changes in functional organization of the brain (e.g., Cacioppo, Bernston, Bechara, Tranel, & Hawkey, 2011), different strategies for regulating emotional reactions (Urry & Gross, 2010), and motivational shifts (Carstensen, 2006). It is now almost taken for granted by researchers studying emotional processing and aging that older adults are happier because they are more effective at emotion regulation (Blanchard-Fields, 2007; Charles & Carstensen, 2007).

As a result of that conclusion, researchers have been investigating age differences in cognitive processes that may reflect or influence emotion regulation. This work has focused primarily on documenting differences between younger and older adults in attention to, and memory for, emotionally-valenced stimuli. Findings that older adults attend to and

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Fredda Blanchard-Fields passed away on August 3, 2010. She fully participated in the conceptualization and writing of this article until she was no longer able to do so, and was able to see a complete draft of it before her passing.

remember more positive than negative stimuli are said to reflect “age-related positivity effects” in cognition (Carstensen & Mikels, 2005).

However, a serious gap in the literature remains: A direct link between age differences in affective outcomes and age differences in cognitive processing has been largely inferred rather than directly established – that is, although there is correlation, we do not yet know whether there is causation. Almost no studies to date have demonstrated that age-related positivity effects in cognition are indeed working *in the service of emotion regulation* to promote happiness in older adults. In this paper, we examine the inference that age differences in cognitive processing of emotional material are emotion regulation strategies that lead to age differences in affective outcomes.

Thus, the first goal of this paper is to evaluate the assumption that age-related positivity effects in cognition are *processes* that directly lead to positive affective *outcomes* in older adults. The second, related, goal is to provide a framework for overcoming conceptual and methodological roadblocks to actually directly test links between potential cognitive processes and affective outcomes across adulthood.

To achieve these goals, we first selectively review past research findings on age differences in affective *outcomes*. Although we consider a range of affective outcomes, including both physiological and subjective measures, our focus is primarily on subjective measures of affect, as that is where most of the research has been done. Second, we (again selectively) review the literature on age-related positivity effects in attention and memory, the primary candidate *process* leading to the aforementioned outcomes. Next, we (1) demonstrate that the assumption of a link between process and outcome can be identified in the current literature, (2) examine the various dangers of making this assumption without compelling evidence, and (3) explore some of the challenges present in trying to discern those links by discussing the few studies that have tested the links explicitly. Finally, we present a framework that will put positivity effects into a larger web of possible processes that may predict affective outcomes across adulthood. Throughout, we use examples from our own work when possible to illustrate both the perils of assuming links between process and outcome, as well as methods that we believe will be useful for directly testing, rather than assuming, those links.

We do not attempt nor claim to provide an exhaustive review of literature on aging and emotional experience, cognitive operations, or emotion regulation, or to consider every possible account for how they may be linked; instead, our focus is on whether the currently available body of research supports the idea that positivity effects in cognition explain positive affective outcomes in older adults, as is supposed in much current literature.

## Evidence for Age Effects in Affective Experience

We concentrate in this paper on one particular outcome regarding emotion and aging: that of “affective” or “hedonic well-being.” This outcome emphasizes the balance between positive and negative affect, such that a person has relatively more positive than negative emotional states<sup>1</sup>.

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<sup>1</sup>This is in contrast to other possible ways of operationalizing well-being, such as the psychological well-being construct of Ryff (1995) with its focus on mastery and psychological growth rather than hedonics, or the more cognitive assessment of life satisfaction judgments (Diener, Suh, Lucas, & Smith, 1999). We focus only on this narrower affective well-being for several reasons: first, it represents the largest body of research on descriptive age differences among the outcomes to draw upon. Second, there is a theoretical framework for making predictions about processes that might predict such outcomes. Third, there are plausible candidate processes involving components that vary in valence (i.e., attention to positive and negative stimuli) in a way that parallels the positive and negative components of affective well-being. Finally, doing so permits us to draw from a related literature on regulation of discrete emotional states, that is often concerned with the down-regulation of negative affective states.

There is good evidence that affective experiences of adults become more positive with advancing age, at least using American samples. For example, Mroczek and Kolarz (1998) reported cross-sectional data from a nationally representative sample of individuals age 25 to 74, in which the oldest age group had both the most positive affect and the least negative affect. Similarly, age changes toward more positive affective experience have been found in longitudinal samples (e.g., Carstensen et al., 2011; Charles, Reynolds, & Gatz, 2001). In a cross-sectional experience sampling study, older adults reported less frequent negative affect than did younger adults (Carstensen, Pasupathi, Mayr, & Nesselrode, 2000). This was also one of the few studies to separately consider affective frequency and intensity: age groups differed in frequency of negative affect, but not on intensity of experienced affect. Similarly, Kessler and Staudinger (2009) found that older adults reported more low-arousal positive affect than younger adults, but that there were no age differences in high-arousal positive affect. Negative affect was lower in the older adults across both low- and high-arousal levels<sup>2</sup>.

It could be that older adults feel so much better because they are generally better at emotion regulation; however, more positive affective experience does not necessarily imply superior regulatory abilities. More importantly, some studies have actually found age-related increase in negative affect in the very old (see Charles, 2010 for a review). One recent longitudinal study found increases in depressive symptoms over a 6-year period in a sample of adults aged 60+ (Dunne, Wrosch, & Miller, in press). A cluster-analytic study of mood change trajectories over time found that older individuals were over-represented not only in the cluster with the most positive affect, but also in the cluster with the most negative affect (Stanley & Isaacowitz, 2011). Charles et al. (2001) found that individuals high in the personality trait Neuroticism did not experience age-related declines in negative affect. Finally, in a lab task, older adults in general were found to be more likely than young adults to rapidly regulate out of a negative mood state. However, despite this group-level advantage for older adults, a substantial number of older adults did not rapidly regulate (approximately 50%: Larcom & Isaacowitz, 2009). These studies highlight an important issue in the search for process-outcome links in that processes will need to explain not only positive affective outcomes in older adults, but negative ones as well.

When considering descriptive age differences in affective experience, emotional *reactivity* can be distinguished from emotion *regulation*: Emotional reactivity (or sensitivity: Koole, 2009) involves the *unregulated* emotional reaction an individual may have to an emotionally-valenced context or stimulus, usually measured with non-self-report tools like psychophysiology. Emotion regulation refers to the ways in which an individual manages their affective state, including their response to potentially emotionally-laden information in the environment. Gross (1998, p. 275) defines emotion regulation as “how individuals influence which emotions they have, when they have them, and how they experience and express them.” Regulation can work on reactivity (cf., Gross & Barrett, in press), such as to down-regulate out of a highly reactive response (calming one's self down after an emotional outburst), or to up-regulate from an inappropriately weak response (not feeling upset enough at a funeral). An individual who is less emotionally reactive may have less need to regulate. In addition, proactive attempts to manage affective experience, such as selecting some situations rather than others, can serve as antecedent (before the response happens) forms of emotion regulation, even in the absence of reactivity (Gross, 1998). The outcome of emotion regulation is the final affective state of the regulator (until the next elicitor comes along).

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<sup>2</sup>While not replicating the positive age effects found for positive and negative affect, studies of life satisfaction and subjective well-being have found mean level stability with increasing age (Diener, Suh, Lucas, & Smith, 1999; Kunzmann, Little, & Smith, 2000), suggesting at least the absence of age-related decline in those aspects of well-being.

In several studies (e.g., Levenson, Carstensen, Friesen, & Ekman, 1991; Levenson, Carstensen, & Gottman, 1994), younger and older adults' psychophysiological responses to emotion-inducing experiences were recorded, in addition to self-reports of affective experiences during the same time period. Some evidence was found for a reduced magnitude of autonomic reaction to the emotional situations in the older adults, whereas no evidence was found for age differences in subjective emotional experience. However, Kunzmann and Grühn (2005) found age similarity in autonomic response to stimuli that were relevant to older adults. The self-report and physiological findings suggest that, while other systems clearly decline with age (e.g., physical and cognitive functioning), the experience of emotion is maintained with age, and some aspects of that experience may even improve (see, for example, Carstensen, Gross, & Fung, 1998).

## Plausible Mechanisms Linking Process and Outcome

Whereas the descriptive evidence points to older adults on average reporting feeling happy, and perhaps more so than their younger counterparts, there are subgroups of older individuals for whom this is not the case. With this caveat in mind, the logical question that follows is how older adults, even on the average level, achieve positive affective experience in their lives. Findings that older adults are on average happier than one might think emerged at about the same time as Laura Carstensen was developing her motivational framework for understanding socioemotional aging, termed socioemotional selectivity theory (SST). Socioemotional selectivity theory originally sought to understand how older adults make social choices; in particular, how they could seemingly prune their social networks so that they interacted less often with social partners but still felt satisfied with those relationships (Carstensen, 1992, 1993). According to SST (see also Carstensen, 2006; Carstensen, Isaacowitz, & Charles, 1999), older adults have a limited time perspective, which causes them to focus on the pursuit of the here-and-now rather than future-oriented goals. This means less interest in novel social partners and more focus on familiar, emotionally close relationships. In other words, under conditions of limited time, individuals prioritize emotional goals of current affective fulfillment and emotional meaning over future-oriented goals, such as establishing new relationships or learning new things. Indeed, there is consistent evidence that older adults do prioritize emotional goals (Fung & Carstensen, 2006). The idea that older adults pursue emotional goals in their relationships could easily be extended to accommodate descriptive findings that older adults were not just happy with their relationships, they were happy overall. With a limited time horizon, older adults pursue emotional goals across domains. Because they care so much about how they feel and make choices in support of it, perhaps the finding that they feel good is not quite so surprising.

SST is not the only theoretical framework that can be harnessed to explain age-related changes in affective experience. Whereas SST posits that changes in time perspective lead to positive affective experience, most of these other perspectives explain age-related positive affective experience (or no overall increase in depression with age) in terms of compensatory response to losses. For example, Labouvie-Vief (e.g., Labouvie-Vief & Medler, 2002) argued that declines in affect complexity (the differentiation of affect) that occur after middle age lead to a corresponding increase in affect optimization (more positive rather than negative affective experience). Heckhausen and Schulz's (1995) life-span theory of control considered links between the use of secondary control strategies (targeted at changing the self rather than the external environment) with age and affective response to changes in the likelihood of accomplishing goals. For example, increased use of goal disengagement - a type of secondary control strategy - with age might reduce the extent to which unachievable goals lead to negative affect (see also Brandstädter, Wentura, & Greve, 1993). One recent study found that withdrawal from unattainable goals allowed older

individuals with elevated functional disability to avoid increased depression (Dunne et al., in press).

Given that these various conceptual frameworks could each explain age differences in affective experience, it is important to directly investigate what processes could plausibly underlie the affective success of older adults in order to assess which conceptual framework is the best match for the data. SST has offered perhaps the most specific account of such a potential mechanism.

## Aging and Cognitive Mechanisms That May Relate to Emotion Regulation

According to SST, prioritization of emotional goals reveals itself in older adults' positivity effects in attention and memory (Carstensen & Mikels, 2005); these positivity effects then become emotion regulatory strategies that lead to positive affective outcomes. SST therefore proposes a path that might explain age differences in emotion regulation and affective outcomes: if age-related shifts in goals change the way older adults process information, these cognitive changes could reflect attempts to achieve the goal of regulating one's emotions, and may lead to positive affective outcomes. As a result, researchers have endeavored to examine age differences in the way individuals selectively process emotionally-laden information in an attempt to provide cognitive processes that *could* be related to emotion regulation outcomes.

Age-related positivity effects in cognition, such as diverting attention away from negative stimuli and remembering relatively more positive stimuli (Carstensen & Mikels, 2005), have therefore received much theoretical and empirical attention in the aging literature. Carstensen and colleagues (Carstensen, Mikels, & Mather, 2006) formally define a positivity effect as age differences in the ratio of positive to negative material in information processing. A recent theoretical statement sums up the link between SST and positivity effects: "Reasoning from socioemotional selectivity theory, the positivity effect reflects motivated cognition operating in the service of emotion regulation. When high priority goals concern well-being, people adaptively focus relatively more on positive than negative information. As operationalized, it does not matter whether the effect is driven primarily by reducing focus on negative material or enhancing focus on positive material. Either way, selective cognitive processing that is relatively positive can benefit well-being (Johnson, 2009; Kennedy, Mather, & Carstensen, 2004)." (Scheibe & Carstensen, 2010, p. 137).

This conceptual framework has led researchers to search for an Age by Valence interaction in laboratory studies examining attention to and memory for emotionally-valenced stimuli. For example, by examining the degree to which an individual directs their attention towards or away from positive or negative stimuli researchers find that older adults avoid attending to certain types of negative stimuli and in some cases attend more to positive stimuli (Isaacowitz, Wadlinger, Goren, & Wilson, 2006a, 2006b; Mather & Carstensen, 2003, Experiment 1). In memory experiments older adults recall and recognize more positive images and neutral images over negative ones in comparison with younger adults (Charles, Mather, & Carstensen, 2003, Experiment 1); they show better performance in a working memory task for positive emotional stimuli in comparison to negative emotional stimuli (Mikels, Larkin, Reuter-Lorenz, & Carstensen, 2005); remember more positive information when recalling autobiographical information (Kennedy et al., 2004; Levine & Bluck, 1997); and remember their decisions as more positive in emotional valence (Mather, Knight, & McCaffrey, 2005).

A typical conclusion drawn from such findings is that older adults' tendency towards a positivity effect serves the purpose of assisting the individual to better regulate their emotions, as shown in the sample quotes from papers (including our own) on age-related

positivity effects shown in Part A of Table 1. As discussed in more detail below, we believe that these conclusions are still primarily speculative and should be considered working hypotheses rather than firmly established links. A larger number of the appropriate direct tests need to be conducted to verify these links.

Beyond that caveat, it should also be noted that there are studies that find that older adults spend more time viewing negative stimuli than positive or neutral ones (Charles et al., 2003) and display a negativity effect (a focus on negative information: Thomas & Hasher, 2006; Wood & Kisley, 2006). A meta-analysis found mostly age-similarity in the magnitude of positive-neutral and negative-neutral preferences in attention and memory (Murphy & Isaacowitz, 2008). Grühn and colleagues (Grühn, Smith, & Baltes, 2005) also found no evidence for a positivity effect in memory, instead finding evidence for a reduced negativity effect in older adults when remembering a list of words with negative, positive, and neutral valence. Similarly, when incidentally encoding pictures, both younger and older adults recalled the central element more than the peripheral elements only for negative scenes. However, when instructed to attend to this difference, younger but not older adults could overcome the memory trade-off (Kensinger, Piquet, Krendl, & Corkin, 2005).

Because our intent in this paper is not to debate the existence of age-related positivity effects in attention and memory, we note at this point simply that the range of findings from cognitive studies mirrors the variability in the previously discussed findings on affective experience in late life; many but not all show age differences supporting age-related positivity. Our focus is rather on the larger regulatory context of the older adult in which positivity effects are found and on how findings concerning positivity in older adults' information processing are interpreted: In other words, do biases in processing emotional information such as the positivity effect, when observed, *actually serve the purpose* of helping the individual to regulate his or her emotional state?

While this conceptual framework specifies a process (age-related positivity effects in attention and memory) and an outcome (positive affective experience), literature demonstrating an age-related positivity effect in cognition does not necessarily directly test whether they are linked. So far, the best that can be said is that descriptive patterns for processes are consistent with descriptive patterns for outcomes, though this is rather indirect evidence for a link. For example, one might note a parallel between relatively more robust evidence for age-related decline in the experience of negative affect compared to increased positive affect, coupled with relatively stronger evidence for age-related changes in attention to and memory for negative as opposed to positive stimuli. This could be viewed as indicative of, though not definitive proof of, a link between lessened responding to negative emotional stimuli (a form of positivity effect) and lessened negative affective experience generally with age.

To test the hypothesis that age-related positivity effects in cognition are *working in the service of emotion regulation*, outcome measures of the short- and long-term consequences of such processing biases must be included in order to truly assess their adaptive value, though they have *not* been included in the vast majority of studies of possible age-related positivity effects to date. If older adults are selectively allocating resources toward positive and away from negatively valenced information, direct tests of this process and links to regulatory outcomes are indicated: What are the emotion regulation strategies that produce selective attention to some emotional stimuli over others? What are their effects on mood and mood change in real time? Below, we consider what needs to be shown to support the hypothesis that age-related positivity effects work in the service of older adults' emotion regulation, and note some critical challenges to testing and contextualizing this hypothesis. We review a small number of studies that have started to test these links directly. We

ultimately present a framework that we hope will generate the kinds of hypothesis-testing that we believe will be most likely to move this field forward, as well as the study of cognition-emotion links outside of aging.

## Testing Direct Links Between Processing of Emotional Information and Emotion Regulation

Attention and memory tasks involving emotional stimuli do not, by themselves, imply anything about emotion regulation processes or outcomes. It is worth pausing to differentiate between the processing of emotional information (below referred to as “PEI”) on the one hand, and emotional reactivity and emotion regulation on the other. PEI involves the presentation of stimuli with some emotionally-valenced content, and assessment of some information processing measure concerning how a perceiver relates to that valenced stimuli (such as attention toward it, memory for it, etc.). However, the dependent variables in PEI tasks index the perceptual and/or cognitive manipulation of the emotional stimulus rather than the effects it has on emotional state of the perceiver. In contrast, both emotional reactivity and emotion regulation involve a real or anticipated response to some stimulus likely to evoke emotion, as opposed to simple manipulation of that stimulus. Whereas seeing a positively-rated word on a computer screen may not elicit any emotional response by the perceiver and thus would indicate only PEI, seeing a highly-arousing negative image will likely lead to some emotional response on the part of the perceiver, in addition to PEI.

The vast majority of research on age-related positivity effects in cognition has used PEI tasks. However, PEI tasks do not imply any emotional response on the part of participants; thus, they are not tests of emotional reactivity or emotion regulation. There is no actually clear and obvious relationship between PEI and downstream affective experience or emotion regulation: it is simply not the case that certain attentional preferences or memory patterns necessarily make people feel better or worse.

The attention and memory tasks used in PEI studies may or not map onto the emotion regulation strategies specified in Gross’ (1998) widely-used process model of emotion regulation, such as attentional deployment and cognitive change/reappraisal. Studies of age differences in selective attention may correspond to the strategy of attention deployment/distraction, but memory processes do not fit clearly into the process model. For example, it is an open question as to whether forgetting negative material (a form of positivity effect) would really count as reappraisal. However, just because they may not mesh together so far empirically does not mean that they could not all fit together eventually: for example, motivational processes such as those specified by SST could plausibly lead both to age-related positivity effects as well as to age-related changes in preferences for, or success of, certain emotion regulation strategies (see Urry & Gross, 2010). Unlike studies using PEI tasks, research on the use of emotion regulation strategies in the lab always uses at least plausibly emotion-eliciting stimuli, and generally measures affective response to them, but generally does not include a specific assessment of the PEI (or lack thereof) of the eliciting stimuli used. This may be changing, though, as some recent studies in which older and younger adults were instructed to reappraise also measured attention via gaze patterns; however, they generally held gaze constant during reappraisal, making it impossible to link strategy, attentional PEI and outcome in these cases (Opitz et al., in press; Urry, 2010).

In one study using emotional words with younger and older adults, positivity effects were found in memory for nonarousing but not arousing words (Kensinger, 2008). This is the opposite pattern to what would be expected if the memory patterns were supporting regulation; positivity effects were found for words that should not have elicited any emotional response that needed to be regulated, but were not found in the context where

regulation was relevant. Kensinger (2008) interprets the pattern as reflecting age differences in the likelihood of elaborating negative as opposed to positive information, which may be a non-regulatory explanation for age differences in valenced memory (because the PEI process does not seem to correspond to the relevant regulatory outcome).

Work from one of our labs (DMI) further illustrates that positive PEI does not necessarily imply positive mood regulation outcomes: in several studies we used synthetic faces displaying emotional expressions and found age differences in fixation to those faces as a function of the emotion expressed (e.g., Isaacowitz et al. 2006a,b), in line with positivity effects. However, the stimuli (see Figure 1) are not designed to elicit any change in affective response themselves, even though they display emotions: there is no image-elicited emotional response to regulate. This is why a later study included a mood induction to introduce the need for regulation (Isaacowitz et al., 2008); while we could assess whether fixation to the faces helped participants regulate their mood over time as described below (Isaacowitz et al., 2009), the faces themselves did not elicit a response nor demand regulation by themselves.

Descriptive studies of age differences using eye tracking found that older adults tended to look toward positive and away from negative emotional stimuli in positive-neutral and negative-neutral pairs (Isaacowitz et al., 2006a, 2006b). However, such descriptive work on emotional processing did not make an explicit connection to emotion regulation, so the gaze preferences could not at that point be said to be working *in the service of emotion regulation*. Importantly, these descriptive findings could also be consistent with more compensatory-based models, such as Labouvie-Vief's: age differences in looking pattern could have nothing to do with mood regulation, or both older adults' positive looking and positive moods could be due to some other common third variable such as neural changes but not directly linked themselves. Thus, directly testing whether the process leads to the outcome is critical for assessing whether positive looking, or any other PEI, could indeed be working in the service of older adults' emotion regulation.

Therefore, recent studies have directly tested whether this process (positive looking, a type of age-related positivity effect) actually leads directly to the outcome of interest, positive affective experience. It has been demonstrated that older adults activate positive gaze preferences when in negative moods (Isaacowitz, Toner, Goren, & Wilson, 2008) and that older adults' positive gaze preferences can actually lead to mood stability or less decline in contexts where the predominant response is one of mood decline, providing some evidence for direct links between emotional processing of this type and downstream emotion regulation (Isaacowitz et al., 2009). In these cases, PEI can be directly linked to regulatory outcomes; more such work is needed before positivity effects (or other types of PEI) can accurately be called "regulatory strategies" that lead to positive affective outcomes.

When research tries to explicitly link types of emotional processing to actual emotional outcomes, a certain problem is likely to arise: namely, that even a particular regulatory strategy that helps some individuals feel good may not help *all* (or even *most*) individuals feel good: there may be meaningful subgroups of individuals for whom the strategies do not work. For example, recent eye tracking work (Isaacowitz et al., 2009) showed positive gaze preferences helped some older adults to successfully regulate how they felt, but there were also older adults who showed the "correct" regulatory strategy – looking more at positive stimuli – but this did not lead them to experience the regulatory outcome of feeling good. So, while the positivity effect in this case may be said to be working generally in the service of older adults' emotion regulation, it does not actually work for some older adults. This type of finding should not be too surprising, given the evidence described above for interindividual variability in affective outcomes within the older group. Nonetheless, linking



cognitive mechanisms to actual affective outcomes will require understanding the subgroup of individuals who do not seem to benefit, even when that processing is an adaptive regulatory strategy for (some) others.

Sometimes PEI is just that: cognitive processing of stimuli with some emotional valence, but without any necessary emotional effects or need for regulation. These cases are important because they force us to consider that the perceiver's attempts to regulate how they feel may not be the underlying mechanism for age differences; for example, these may be cases where age changes in neural function and/or connectivity are most likely to show their influence. For instance, age-related differences in PEI for positive stimuli may arise from changes in neural regions involved in self-referential processing (Kensinger & LeClerc, 2009). Finding age differences in PEI tasks by themselves may indicate differential preferences for processing emotionally-valenced material, but these age differences in preferences cannot be said to be facilitating emotion regulation, as such studies do not test whether this is true or not.

## Emotion Regulation Across a Range of Cognitive Resources

If positivity effects in attention and memory could be shown to be emotion regulatory processes that lead older adults to have positive affective experience, what individual difference variables might moderate this relationship? Mara Mather's work has suggested that cognitive control is necessary for older adults to display positivity effects, such that older adults should only be able to strategically deploy top-down control of their attention and memory in a more positive direction when they are in possession of strong underlying cognitive resources. The idea that older adults can only display positivity effects when they have substantial cognitive resources meshes well with the notion that positivity effects arise due to older adults' goals, so top-down goal-driven influences on cognition may use up cognitive resources (Kryla-Lighthall & Mather, 2009). While control and resources are certainly not synonymous (e.g., Moors & de Houwer, 2006), aging studies sometimes use individual difference measures of resources that are thought to constrain the ability to control processing of emotional stimuli. For example, older adults show a positive memory bias, but only at full attention or when in possession of high levels of cognitive resources (Mather & Knight, 2005). Similarly, while older adults showed positive looking preferences at full attention, they displayed a reversed pattern – looking more at negative – when their attention was divided by a distracting task (Knight et al., 2007).

This “cognitive control” perspective would suggest that cognitive control ability is essential for older adults to use positivity as an emotion regulatory strategy; sample quotes illustrating this perspective can be found in Section B of Table 1. However, just like PEI tasks cannot be assumed to relate to emotion regulation, studies of the role of cognitive control in producing PEI do not imply emotion regulation either. Only studies that link cognitive control and PEI to actual affective outcomes can assess whether cognitive control is key to older adults' use of positivity effects for emotion regulation. Recent research has started to test this, and has found that older adults who score highly on a measure of executive functioning can actually resist mood declines when they show a positive looking pattern, whereas older individuals with lower levels of executive functioning displayed positive gaze patterns but did not feel good (Isaacowitz et al., 2009).

These findings raise important issues relevant to potential links between age-related positivity effects and positive affective outcomes. In the Mather work arguing that cognitive control is necessary for older adults to display positivity effects, affective outcomes were not assessed; therefore it is possible that low cognitive control older adults who did not show positivity effects might have had positive affective outcomes (presumably via some other

pathway). At the same time, our finding that older adults can sometimes show positivity effects in attention but not experience positive affective outcomes further suggests that age-related positivity effects alone may not be responsible for all positive affective outcomes shown by older adults. If age-related positivity effects only lead to positive affective outcomes for older adults with good cognitive control, then studies that do not consider such moderators might not be fair tests of process–outcome links. To the extent that the process of age-related positivity effects leads to positive affective outcomes for the subset of older adults with this resource, then what processes (other than positivity effects in attention and/or memory) might lead to positive affective outcomes for older adults *without* good cognitive control?

While this question is primarily one for future research to answer, there are already some hints in the literature. Despite one study's finding that instructions to down-regulate disgust disrupted working memory performance in young adults (see also Richards & Gross, 2000), but not in older adults (Scheibe & Blanchard-Fields, 2009), another recent study found older adults to be *less* efficient in using the specific regulatory strategy of cognitive reappraisal than their younger peers (Opitz, Rauch et al., in press). Thus, older adults may sometimes favor other regulatory strategies that are easier for them depending on their cognitive abilities; below, we consider the possibility that situation selection may be a favored strategy in these cases.

Some might argue that this is an area of overlap with lab research on emotion regulation strategies; for example, the idea that older adults do not show positivity when distracted could be seen as parallel to findings that older adults have difficulty displaying some kinds of cognitively-demanding reappraisal (Opitz). However, the similarity is not complete, as older adults do sometimes display positivity in fixation even when distracted (Allard & Isaacowitz, 2008), and older adults *can* use some forms of reappraisal quite well (Shiota & Levenson, 2009). The mapping of cognitive abilities to regulatory strategies is still a work in progress; but, even if positivity effects can be shown to be effective emotion regulation strategies for some older adults to achieve positive affective outcomes, there are clearly other possible mechanisms and strategies that also need to be considered.

Perhaps surprisingly, though, some theories posit that older adults' positivity in attention and memory actually *results from* declining resources. For example, Labouvie-Vief and colleagues (2010) have argued that older adults use positivity as a compensatory tool to deal with declining physical and cognitive resources: without the resources to engage with the complexities of negative material, they may avoid it in favor of simpler positive material (Consedine, in press). Although this theoretical stance has also not been explicitly linked to mood outcomes, it provides an interesting juxtaposition to the SST perspective and clearly needs further investigation of process–outcome links. Finally, there is also evidence that older adults' emotion regulation efforts may not be related to their cognitive resources at all. Recent work using pupillometry did not find any evidence of increased dilation (a psychophysiological indicator of effort) when older adults showed positive looking preferences (Allard, Wadlinger, & Isaacowitz, 2010).

Why are these different findings and theoretical perspectives important to our question of whether age-related positivity effects in cognition actually lead to positive affective outcomes? If positivity effects lead to happiness for some older adults but not others, studies looking for the links should expect to find it some cases but not others, and should not expect to find it generally for older adults. If resources are the critical moderator for these links, that would support SST's explanation of positivity effects over competing explanations that they result from a *lack* of resources. If regulatory strategies are identified that do not involve positivity effects in attention and memory, these processes will

ultimately need to be considered alongside positivity effects to understand pathways to positive affective outcomes in older adults.

Therefore, the fact that the conceptual and empirical picture regarding links between positivity effects, cognitive resources, and affective outcomes is currently quite inconsistent represents a serious constraint on the ability to make firm conclusions about these links.

## Young Adults Need Emotion Regulation, Too

So far we have focused our consideration primarily on the potential role of cognitive processes in helping older adults to feel good. But what about younger adults? From some research on aging and emotion-cognition links, one might get the impression that younger adults do not regulate their emotions. In a typical study, younger and older adults attend to or remember valenced information; if Age by Valence interactions are found consistent with the idea of age-related positivity effects, the finding is interpreted as reflecting older adults' pursuit of emotion regulatory goals. But, what are younger adults doing? Adult developmental research on cognition – emotion links cannot just explain the behavior of one age group and ignore the other. If, in the standard cognitive paradigms, older adults are using positivity effects in attention and memory to feel good, how can we explain findings of young adults showing no preference or even negativity biases (e.g., Isaacowitz et al., 2006b; Mather & Carstensen, 2003)? Findings of so-called “negativity dominance” in young adult samples tend to be interpreted as reflecting the stronger evolutionary demands of negative (death) as opposed to positive (not death) stimuli (e.g., Rozin & Royzman, 2001). Putting aside the question of why evolutionary demands would not apply to older people, the implication is that negative preferences in the young are not about emotion regulation.

However, recent research suggests that young adults may sometimes use negative cognition itself as a regulatory tool. In the study described above, the younger adults who were most able to stave off mood declines were those who had good executive control and actually showed a more *negative* looking pattern (Isaacowitz et al., 2009). In another study, younger adults felt better when they looked relatively more at negative images compared to their own average looking tendency (Noh, Lohani, & Isaacowitz, in press). While this may seem surprising, one speculation is that this looking pattern actually reflected a different underlying regulatory strategy than what the older participants were doing. Whereas the older adults were using attentional deployment as a regulatory strategy, young adults may have been using reappraisal (see also Urry, 2010). Reappraisal, a regulatory strategy that has its influence relatively later in the emotion generation process as compared to attentional deployment (see Gross, 1998), may thus involve more actual engagement with the emotion-eliciting stimuli (see also Sheppes & Meiran, 2007). In other words, young adults may engage with negatively-valenced material as a part of their ultimate reappraisal; they may be looking at the negative as a way to ultimately feel positive outcomes (Isaacowitz & Noh, in press). A related but distinct possibility is that engagement with negative stimuli is used by younger adults to create downward social comparisons, which can sometimes enhance self-evaluations (e.g., Lockwood, 2002). Interestingly, there appear to be age differences in comparison processes (Rothermund & Brandstädter, 2003).

Alternatively, younger adults' looking patterns may be serving other goals separate from emotion regulation altogether: SST might predict younger adults would be gathering information from their environment (see also Charles & Carstensen, 2008), whereas Tamir's (2009) work might predict that they are pursuing instrumental, contra-hedonic goals that could be useful in the future. Findings of adolescents reporting contra-hedonic motivation have been interpreted as reflecting their attempts to practice responding to and regulating negative emotional experiences (Riediger, Schmiedek, Wagner, & Lindenberger, 2009; see

also Wrosch & Miller, 2009). While it may not be possible to directly extrapolate to younger adults from findings on adolescents, it is still relevant and important for life-span developmental researchers to know a) what younger adults are doing in cases where older adults are thought to be regulating emotions, and b) what younger adults in fact do when they are actually trying to regulate their emotions.

## A New View on Linking Process and Outcome in Emotion and Aging

As noted previously, there is considerably more variability in the affective experience of older adults than is usually addressed in discussions of the “positivity” of older adults. On top of that variability, there are individual differences in the potential cognitive predictors of such experiences and also in the ways that cognitive processes, like positivity effects, actually relate to affective outcomes. Above, we considered that the cognitive resources the perceiver brings to the task of using their thinking to regulate their emotions may be a key moderator of whether positivity effects are displayed, and whether those effects lead to positive affective outcomes when displayed. What other individual differences may affect regulatory processes, regulatory outcomes, and the links between them?

One set of possible individual difference characteristics involves motivation. While there may be an age-related increase in hedonic motivation (Riediger et al., 2009), there nonetheless could be variability in the extent to which that is true for each older adult. For some, instrumental motives (e.g., motivation to perform a certain behavior) could outweigh hedonic ones (see also Tamir, 2009). There are probably some older individuals (usually or in some situations) who do not value hedonic goals as much as other ones, and thus are not strongly motivated to optimize their hedonic state. Even within the umbrella category of hedonic motivation, there could be variability in the particular outcome goals: some perceivers may want to maximize positive affect, others to minimize negative affect, and others to avoid any high arousal state (see also Keil & Freund, 2009). Some may define successful regulation as maintenance of a reasonably good state, or avoidance of a worse one, whereas others only feel successful in their regulation when their affective state has actually improved. There could also be variability in the reasons that an older adult does pursue hedonic goals: some could do so because they care deeply about the affective tone of their lives, others because it allows them to not devote limited resources to deeply confronting negative situations (see Consedine, in press; Consedine, Magai, & Bonanno, 2002). These motivational processes could also vary within, not just between, individuals. Beliefs about the controllability of emotions may also vary between people (Tamir, John, Srivastava, & Gross, 2007).

Beyond individual differences in person variables like cognitive functioning, motivation, beliefs, and criteria for successful regulation, there are also likely important differences between the regulatory demands of different contexts. Sometimes we can easily ignore affectively-laden stimuli in our environment; other times they are not as easy to ignore. Similarly, some affective stimuli last only a moment, while others extend in time, continuously or intermittently, predictably or suddenly. Certain types of regulatory strategies are likely better suited to some situations than others: for example, regulating attention deployment (gaze) is better suited to affective stimuli that are relatively brief and without overwhelming bottom-up attention-grabbing qualities (such as flashing lights or loud noises). A critical component of any theory and/or research on emotion regulation is the ability to explain and predict not just successful regulation, but also attempts at regulation that are not successful. To do this, attention must be paid not just to the regulator but also to the nature of what needs to be regulated. This may be an area of greater age similarity than age difference, though research on age-relevance of emotional stimuli (e.g., Kunzmann &

Grühn, 2005; Teachman & Gordon, 2009) suggests that individuals of different ages have different adaptive responses to the same elicitors.

An intermediate possibility is that older adults selectively expose themselves (insofar as they have control over this) to elicitors that they are comfortable dealing with (e.g., Charles & Piazza, 2009). This is consistent with research on emotional problem-solving suggesting that older adults avoid unpleasant (Birditt & Fingerman, 2005) and angry (Blanchard-Fields, 2007) situations. Older adults low in cognitive resources may be especially likely to use situation selection as an emotion regulation strategy (see also Charles & Piazza, 2009), thereby avoiding the need to process potentially disturbing material altogether. Considering situation selection as a regulatory process in itself requires a conceptualization of regulation that includes proactive attempts to avoid reactivity in the first place, but may be necessary to fully map out the space of older adults' strategies to manage their affective experience (see also Charles, 2010).

Relatedly, age-related positivity effects may lead to affective outcomes in different time horizons. The few studies so far that have attempted to link positivity effects to mood have done so in relatively short intervals, such as by investigating how fixation and mood relate within minutes (Noh et al., in press) or how fixation predicts mood change from the start to end of a task (Isaacowitz et al., 2009). It is possible that some affective outcomes of age-related positivity effects might not reveal themselves until later in time; moreover, existing modes of assessing affective outcomes may not be sensitive enough to pick up all potential effects. Therefore, lack of evidence to date need not necessarily imply a true lack of process-outcome links; future work should include a range of affective outcomes in diverse time frames to truly test for possible links.

Ultimately, then, what is likely needed to link process and outcome in the study of emotion and aging (at any age) is a matrix in which individual differences in person-level variables lead to particularly favored regulatory strategies. These strategies may or may not be well-matched to the demands of affective situations and thus may or may not lead to successful emotion regulation (particularly if the criteria for that is the absence of negative emotional states and the optimization of positive ones) within some time frame. Age could affect any (and all) of these relationships: what strategies are favored (and by whom), what strategies are best matched to what circumstances, and how each particular configuration predicts the downstream success of regulatory efforts. These are at least conceptually distinct questions, as person-level variables could lead to preferences for cognitive approaches, but these cognitive approaches may not actually relate to positive regulatory outcomes. Age-related positivity effects may figure prominently in this matrix.

Put another way, an alternative to current models of thinking about process and outcome in the study of emotion and aging is to conceptualize a framework with a series of possible pathways linking certain cognitive operations (assessed with PEI tasks) with particular regulatory outcomes (such as mood change over time). There are at least 4 ways PEI could relate to regulatory outcomes. First, PEI may have no influence on regulatory outcomes in some contexts. For those situations in which an individual's processing of emotional information *does* relate to how they end up feeling, it may be that a) accurate, b) positive, or c) negatively-biased PEI predicts the best mood outcomes. Person-level features may change the probabilities that certain types of PEI are preferred in a particular context and/or that they lead to positive affective outcomes in that context. These possible pathways are shown in the top panel of Figure 2.

Why is this framework needed? We believe that it can help encourage a determination of when and whether and for whom age-related positivity effects in attention and memory leads

to positive moods; it would also clarify when age differences in processing of emotional information do not result in emotion regulation at all. Without such a framework, the field of emotion and aging risks ignoring important nuances and complexities in how older adults actually *do* manage their affective experience, and an opportunity for aging research and its functional account of process-outcome links to inform the more general study of emotion and its regulation would be missed.

There are already good hypotheses from existing conceptual models that could be tested within the context of these pathways. For example, age may increase preference for positively-biased PEI (positivity effects) and increase the likelihood that it will lead to positive emotional outcomes. But, this may only be the case for individuals with certain profiles of factors (like good attentional abilities) and in certain situations. It may be that low-resource older adults can sometimes display positive PEI but that it does not predict positive affective outcomes for them. This would support the importance of keeping the two components distinct, and also could resolve some discrepant findings on the role of cognitive control. If older adults display positivity effects in their cognition in some contexts regardless of resources, but they only lead to positive emotion regulatory outcomes for those with adequate cognitive resources, that suggests a way in which SST and compensatory explanations for positivity effects could both be true. Young adults may be more likely to benefit from negatively-biased PEI, based on results from work suggesting functional links between engagement with negative material and better mood over time for younger adults only (see Isaacowitz & Noh, in press). The bottom panel of Figure 2 shows the simple age difference hypothesis; our hope is that the framework will inspire consideration of more complex configurations of person-level and situational predictors and moderators as well.

Research using this framework could help determine what explanatory models are complementary and which are not: for example, a motivational explanation would be supported if (1) older adults flexibly engage positive PEI in certain situations, and (2) when it is engaged, positive PEI frequently leads to positive affective outcomes for older adults. Compensatory explanations would be implicated if preferences for positive PEI preferences relate to lower levels of cognitive or other resources. Age differences in regulatory strategies from the process model such as reappraisal will eventually need to be integrated with these explanations.

Some individual difference characteristics may be associated with flexibility between PEI types, such as positive PEI in situations where there is no cost to ignoring negative information, and accuracy when a cost to ignoring exists. It may be that individual difference factors emerge most strongly for intermediate stimuli, because threatening stimuli are aversive to everyone (Wilson & MacLeod, 2003). Other characteristics may be associated with rigid adherence to a particular PEI approach, which may be related to positive affective outcomes in some situations but not in others. For example, following Labouvie-Vief's recent work (e.g., Labouvie-Vief et al., 2010), an older adult may rely on a positive path to compensate for declines in cognitive and physical functioning, and this may help them feel good when watching TV but not when dealing with an ongoing family conflict or protracted medical situation. Similarly, a young adult may rely on a negative path in a domain in which they wish to build their skills of coping and persistence, but a positive path in domains not considered important.

The tendency for research to date to focus primarily on the simple question of whether older and younger adults differ in their cognitive responses to affective information is therefore an important piece, but just one piece, of the complicated (but not impossible) matrix that is needed to comprehensively link process and outcome. Such studies are about one part of the process but are mostly mute on outcome. Our hope is that future research will focus on

locating processes -- such as age-related positivity effects -- within the framework, and explicitly linking them to outcomes. The question for future research therefore should not be *who shows positivity effects* but what is the pathway from information processing to feeling good for someone in this situation with these particular qualities? While these efforts promise to be messy (and unlikely to yield the simple age effects or Age by Valence interactions that make PEI studies so satisfying), they are necessary to actually delineate the mechanisms that allow (some) older adults to (sometimes) successfully regulate their emotional experience. Any study that aims to link PEI as a process in the service of regulatory outcomes needs to have those outcomes (such as mood) as a dependent variable. While there may be studies of this sort that are amenable to analysis of variance, researchers may need to lean toward regression, multi-level modeling, or dynamic systems modeling (Kuppens, Oravicz, & Tuerlinx, 2010) to analyze predictors of such a dynamic dependent variable (see also Isaacowitz & Riediger, in press).

## Implications for Research on PEI and Emotion Regulation at Any Age

Research on cognition – emotion links generally has spanned from studies of how perceivers process emotional stimuli, which do not necessarily involve emotion regulation at all, to studies in which perceivers are presented with emotion-eliciting stimuli and their (cognitive) attempts to regulate are assessed naturalistically or manipulated. While the latter paradigm clearly involves the regulation of emotion, watching an emotion-eliciting film and then regulating one's feeling state is only one of many ways in which emotion regulation happens in everyday life.

A key implication for the study of emotion regulation generally that emerges from a consideration of *age* effects is that the lab paradigms that have been enormously useful and important for isolating the processes involved in emotion regulation may capture only a subset of the ways in which such regulation is actually carried out (see also Koole, 2009). Much emotion regulation happens while people are ambulatory, with other demands on attention beyond just the eliciting stimulus. Emotion regulation in the real-world may be more like walking and talking on a cell phone at the same time rather than like just checking email, and older adults have more trouble with dual-task performance, thus making any successful regulatory efforts even more impressive. In the life-span developmental tradition, the study of emotion and aging may actually provide a key “testing-the-limits” approach (Baltes, 1987) that elucidates mechanisms that do and do not link cognition to emotion and its regulation at any age. Our framework could help link motivational theories and cognitive measures to models of emotion regulation and affective outcomes, permitting a more integrated approach to studying predictors of mood change in real-time for individuals of any age.

Not all regulatory efforts succeed, and emotion regulation research generally would benefit from attention to regulatory failures in addition to success (see also Charles, 2010). At the same time, many different kinds of people, not only of different ages but also of different ability and resource levels, can (at least) sometimes and/or in some time frames successfully regulate how they feel despite all the challenges inherent in doing so. How individuals regulate the effects of potential emotion elicitors in this dynamic, competitive environment is the next challenge for research in emotion regulation generally, and the case of older individuals may provide key insight into these more general processes by helping researchers disentangle when PEI is just PEI, and when positivity effects in cognition actually lead to happiness.

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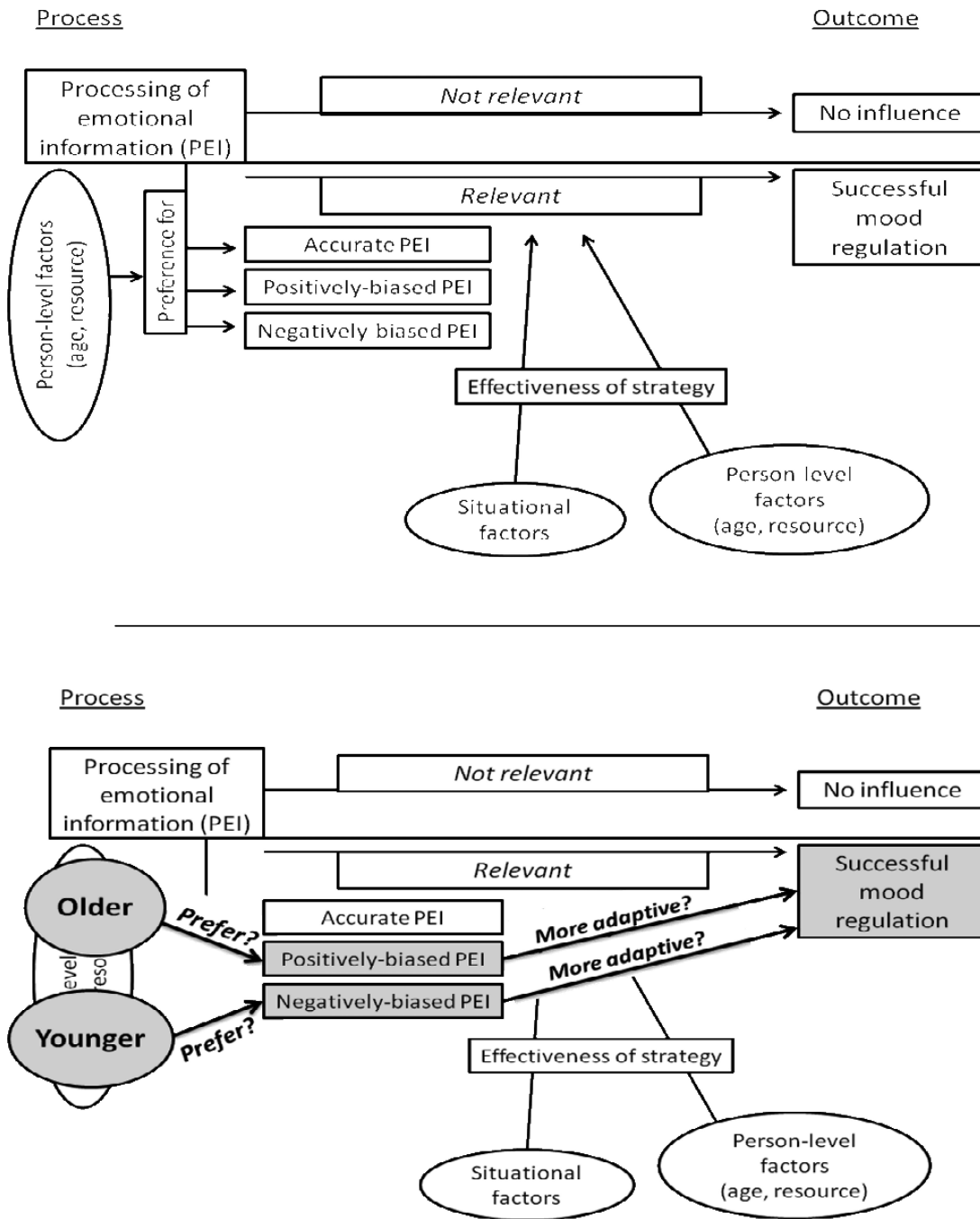
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**Figure 1.** Examples of synthetic face stimuli used in several studies (e.g., Isaacowitz et al., 2006a, b, 2008) showing the same synthetic individual displaying (from left to right) neutral, angry, afraid, sad and happy expressions.



**Figure 2.** Top panel: Proposed framework for linking process and outcome in the study of emotion and aging. Bottom panel: Simplest version of age difference hypotheses to be tested in this framework, including preferences for particular processes and their likelihood of leading to adaptive outcomes.

Table 1

## Quotes relevant to process-outcome links

A. Sample quotes illustrating general framing of age-related positivity effects as functioning in the service of emotion regulation	Authors (year, page)
“we review recent empirical evidence that memory and attention operate, in part, in the service of emotion regulation.”	Carstensen, Mikels, & Mather (2006, p. 343)
“We interpret this finding as suggesting that older adults reconstruct the past in such a way as to accentuate the positive, and, as others have suggested, this may reflect efforts at emotional regulation in older adults.”	Fernandes, Ross, Wiegand, & Schryer (2008, p. 304)
“This preference would serve the general motivational function of protecting the aging individual from some potential bad news while also helping them to more successfully regulate their affective lives and maintain their well-being (see, e.g., Carstensen, Fung, & Charles, 2003).”	Isaacowitz, Wadlinger, Goren, & Wilson (2006b)
“This selective preference in memory for positive information can potentially serve to optimize older adults’ well-being in the present. In this sense, the increased salience of positive material with age could be understood as a culturally insensitive adaptation process promoting emotional well-being.”	Kwon, Scheibe, Samanez-Larkin, Tsai, & Carstensen (2009, p. 752)
“Furthermore, supporting effective emotion regulation, older adults are more likely than younger adults to show positivity effects in attention and memory.”	Mather (2010, p. 336)
“This reduction of negative memories (without an increase in positive memories) is likely to support a positive emotional self-concept in old age.”	Schlagman, Schulz, & Kvavilashvili (2006, p. 169)
“The elderly are thought to have a <i>positivity bias</i> , which allows them to allocate a greater proportion of their attention to positive stimuli than do young adults (Carstensen & Mikels, 2005; Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2003, 2005) and to make greater use of positive emotion in the service of emotion regulation and coping (Charles & Carstensen, 2007; Folkman, Lazarus, Pimley, & Novacek, 1987; Isaacowitz, Toner, Goren, & Wilson, 2008).”	Shiota & Levenson (2009, p. 891)
B. Sample quote illustrating hypothesized role of cognitive resources in older adults’ positivity	Authors (year, page)
“We present behavioral evidence that older adults use cognitive control to enhance their current emotional states... We present findings indicating that older adults use cognitive resources to regulate emotion... Cognitive control allows people to direct attention and memory in ways that help satisfy emotional needs. Using cognitive control as an emotion regulation tool becomes increasingly useful with advancing age as emotional wellbeing takes on more importance to those with more limited futures.”	Kryla-Lighthall & Mather (2009, p. 324)