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Integrating cognitive and emotion paradigms to address the paradox of aging

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Abstract

Thirty years ago, the subfields of emotion and cognition operated relatively independently and the associated science reflected the tacit view that they were distinct constructs. Today, questions about the integration of cognition and emotion are among the most interesting questions in the field. I offer a personal view of the key changes that fuelled this shift over time and describe research from my group that unfolded in parallel and led to the identification of the *positivity effect.*

Keywords

Aging; positivity effect; socioemotional selectivity theory; history psychology

When I began my career in the late 1980s, it never crossed my mind that affective science would become an established subfield within psychology or that interactions between cognition and emotion would be a major focus of research. A great deal has changed since then.

Below, I offer an historical account of the reasons for the relative independence of emotion and cognition within psychology and the eventual integration of these two constructs. I then describe the *positivity effect* – a developmental phenomenon that reflects cognitive processing in the service of socioemotional goals – as an example to illustrate the interplay of cognitive and affective processing.

My historical account

Thirty years ago, cognitive psychology was emerging as the dominant conceptual approach in psychological science. Psychoanalytic paradigms had been rejected as unscientific, and consensus was building that behaviourism – which maintained that mental processes were ill-suited for experimental science – was too restrictive to provide a full account of human experience. The study of the mind was becoming the focal point in experimental psychology

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and substantial progress was being made in this endeavour. Cognitive paradigms were elucidating implicit memory (Schacter, 1987), mental representations (Cooper & Shepard, 1975), and heuristics in decision processes (Tversky & Kahneman, 1983). Philosophical debates were moving forward in parallel, fuelled by advances in computer science that allowed for simulations of mental processes, with artificial intelligence emerging as a field that integrated cognitive psychology, linguistics, and mathematical modelling (see Anderson & Bower, 1974).

Emotion, in contrast, was considered the domain of clinical psychology and, while the presumptive aim of clinical psychology was (and is) the integration of science, theory, and practice, the integration in this area was weak. Whereas research training in clinical programmes was consistent with training in other areas of psychology, the practice arm bore little relation to science. Concepts that had no empirical basis (e.g. transference, ego strength, and projective testing) were included in clinical training programmes.[1] While there were many superb clinical scientists – note that virtually *all* of the leading figures in affective science were clinically trained – the *profession* remained closely tied to psychodynamic and humanistic approaches to therapy. It was a time when we regularly spoke of “hard” and “soft” science – something I rarely hear today – with cognitive psychology considered a hard science, and the study of emotion representing the softer side of psychology.

Further complicating matters, over the same years that cognitive science was flourishing, the field of clinical psychology came to be dominated increasingly by practitioners. The emergence of free-standing and forprofit professional schools in the 1970s meant that hundreds of practitioners were graduating each year from schools that emphasised psychotherapy over science, while only a handful of scientist-practitioners were graduating from university-based clinical psychology doctoral programmes. Indeed, within a matter of years, practitioners vastly outnumbered scientists in the American Psychological Association (APA). APA came to operate more as a guild that advocated for insurance reimbursements and prescription drug privileges for practitioners than as a research organisation. Basic scientists began to resign from the organisation and a new organisation was formed to provide a home for scientific psychology. Originally named the American Psychological Society and later changed to the Association for Psychological Science, APS became the primary organisation for psychological science. Although initially there was little interest among the leaders of APS to include clinical psychology per se, affective science was another matter and methodological advances and substantive insights during the 1990s increased scientific attention to emotion across all subdomains of psychology.

Methodological advances in the study of emotion

The 1980s and 1990s witnessed substantial innovations in methodologies used to study emotion and emotional disorders. The Facial Action Coding System (FACS) was introduced by Ekman and Friesen (1978) and became recognised internationally as a reliable tool for

[1]Notably, both Stanford and Harvard closed their clinical training programmes because of oversight of professional training by APA which required the teaching of projective testing and other non-empirically supported activities.

identifying facial expressions and associated facial expressions with subjective reports and physiological profiles. Robert Levenson, Richard Davidson, and John Cacioppo introduced the study of emotion within the field of psychophysiology (Cacioppo, Martzke, Petty, & Tassinary, 1988; Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Ekman, Levenson, & Friesen, 1983; Levenson, 1992). Ian Gotlib and Colin Macleod began to apply traditional cognitive paradigms, such as the Stroop and dot-probe tests, to assess information-processing biases in both clinical and non-clinical samples (Gotlib & McCann, 1984; MacLeod, Mathews, & Tata, 1986). Janice Kiecolt-Glaser and Ronald Glaser articulated the effects of emotional arousal on immune functioning (Kiecolt-Glaser & Glaser, 1992). Research on schizophrenia – previously viewed as a *thought* disorder – showed that it was just as much an emotional disorder (Berenbaum & Oltmanns, 1992). "Expressed emotion" in the family was shown to predict patient relapse in schizophrenia (Butzlaff & Hooley, 1998).

In my view, the introduction of neuroimaging in the 1990s settled any uncertainty that emotion was an appropriate subject matter for psychological science. Combined with the observation of central nervous system activation in psychophysiology, realtime demonstrations of neural activation greatly informed our understanding of emotional processing and emotional regulation. The identification of neural circuits elucidated how dedicated brain regions previously studied in isolation operate synchronously. Affective neuroscience emerged as clear scientific area. Emotional phenomena were no longer viewed as "fuzzy" concepts and came to be characterised by a coherent set of neural and physiological features.

Important thinkers, mentors, and leaders in the field

It would be a mistake to think that methods alone drove the science. There were giants in cognitive psychology, such as Gordon Bower, whose attention to mood and memory built bridges across personality, clinical, and cognitive science. And there were debates, some heated, that captured the attention of social, cognitive, and clinical psychologists while clarifying important issues concepts in the field. One particularly notable debate occurred between Richard Lazarus and Robert Zajonc. Whereas Lazarus (1984) maintained that emotional states were the end result of the process of cognitive appraisals, Zajonc (1984) maintained that "affect needs no inferences" and argued, instead, that affect often comes first and appraisals justify affective states.

There were also generous teachers and mentors without whom the field would not be what it is today. John Cacioppo dedicated considerable time and effort gathering social psychologists from around the country to train them in the use of psychophysiology so that more attention would be paid to the physiology of emotion. In 1989, with funding from the NIH, Paul Ekman, Richard Lazarus, and Robert Levenson established the Affective Science post-doctoral training programme at the University of California at Berkeley and the University of California at San Francisco. Ekman was determined that every major psychology department in the country would include an emotion researcher on the faculty. The training programme produced scientists like Dacher Keltner, Barbara Fredrickson, Brian Knutson, and many other leaders in the field today. Fast forward twenty-plus years: in 2012,

James Gross and Lisa Feldman-Barrett founded the Society for Affective Science to provide a venue for emotion researchers to convene annually and to offer a professional home to affective scientists.

Without these key figures, ideas, and advances in research, it is unlikely that affective science would have emerged as it did. All of these researchers raised the status of emotion as a scientific target. Today, I think it's fair to say that some of the most interesting questions in psychology are those concerning the ways that emotion and cognition interact.

Influence on my research programme

I was trained in both clinical and life-span psychology. When I began my career, I was interested in social isolation in elderly adults and the presumed despair that surrounded it. Social networks grow smaller with age and, at the time, it was "textbook knowledge" that rates of depression were very high in older people. I assumed that these two phenomena were linked.

Over time, I discovered that many of my early assumptions were wrong. Although social networks do grow smaller with age, as research on aging progressed it also became clear that older people have *lower* rates of mental health disorders and more emotional balance in their daily lives than their middle-aged and younger counterparts. This juxtaposition of smaller networks and better emotional wellbeing was termed *the paradox ofaging*. The observation not only provoked questions about aging; it challenged our basic understanding of happiness. Although many of the assets that presumably lead to happiness (e.g. robust health, mental acuity, broad social networks, social status) are reduced with age, people nevertheless seem to grow happier.

I formulated socioemotional selectivity theory (SST) to address this paradox. My colleagues and I have tested and refined this theory over the years as our initial hypotheses were rejected and new findings were generated. Detailed articulations of the theory are available elsewhere (Carstensen, 1992, 2006; Carstensen, Isaacowitz, & Charles, 1999). The cardinal postulate of SST is that viewing the future as long versus constrained influences goal hierarchies that guide action in daily life. In a series of studies, we have shown that when endings are approached, regardless of age, people tend to take stock of life and invest in things that are most important to them. Because time horizons are correlated with chronological age, goal hierarchies tend to change systematically with age. According to SST, when time horizons are long and nebulous, people are motivated to explore, gain knowledge, and expand their worlds. In contrast, when time horizons are constrained, goals about emotional meaning and satisfaction take priority: people live in the present and focus on the things in life that matter most. According to SST, engaging in meaningful goals benefits mental health and contributes to emotional well-being and happiness.

This theory has been applied extensively to questions about the composition of social networks and the quality of social relationships. It has been applied to preferences, decision making, and motivation. The stream of research particularly relevant to the present volume, however, concerns the positivity effect. There is no doubt in my mind that this work evolved

as it did because of the historical context, controversies, and debates described above. My thinking was greatly influenced by the opportunity to work with several key leaders in the field of emotion, including Paul Ekman, Wallace Friesen, Robert Levenson, and John Gottman, and by input from my Stanford colleagues and the intellectual community they represent. In the remainder of my comments, I describe the contributions from my research group that represent the integration of emotion and cognition.

In the early 2000s, my group began to investigate the potential influence of goal changes on cognitive processing. Goals direct cognitive resources, and we reasoned that if goals change systematically with age - and they do - then there may be age differences in the types of information that people see, hear, and remember. In one early study, Susan Charles and I tested the hypothesis that older people remember emotional information better than other relevant material (Carstensen & Turk-Charles, 1994). Our findings confirmed the hypothesis: when older and younger people recounted a story that contained both emotional themes and detailed plotlines, the older people would recall relatively more information about the emotional themes. In a series of studies, Helene Fung and I examined memory for products and slogans featured in advertisements (Fung & Carstensen, 2003). We developed pairs of advertisements in which the images and products were identical in the pairs while the slogans differed. Some slogans promised emotionally meaningful rewards; others pointed to ways that the products would help them explore. Older, but not younger, people remembered relatively more of the products and slogans from the emotionally meaningful advertisements. We considered these findings informative for cognitive aging in general. Most studies of memory in cognitive aging exclude emotional stimuli because they are deemed too ambiguous or potentially idiosyncratic. While these are reasonable concerns, our findings suggested that this practice may put older people at a disadvantage in studies of memory.

Mara Mather arrived in my lab as a post-doctoral fellow in 2000; that same year Susan Charles returned to the lab as a visiting fellow. Mather had been studying choice supportive memory in older people with Marcia Johnson at Yale. My group was beginning to think more deeply about the effects of motivational factors on cognitive performance. We began to consider whether emotional material of all kinds would be salient to older people, or whether they would display a preference for positive information. From the perspective of SST, we anticipated a preference for emotionally positive stimuli, as such a preference would contribute to emotionally satisfying states. At the time, however, there was a substantial body of evidence that spoke against this possibility, and considerable empirical support for attention-grabbing properties of negative stimuli. Baumeister, Bratslavsky, Finkenauer, and Vohs (2001) argued that a negativity bias in humans was so widely evident that it could be considered a fundamental principle of human behaviour. Yet, the majority of this prior research had been conducted with young people.

Charles, Mather, and I designed a study in which we presented positive, negative, and neutral IAPS images to young, middle-aged, and older adults (Charles, Mather, & Carstensen, 2003). Using an incidental memory paradigm, we asked participants to simply view the images on a computer screen. Later, we asked them to recall all of the images they could remember. Our dependent variable was the relative proportion of positive, negative,

and neutral images they recalled. Compared to the youngest participants, middle-aged participants exhibited a modest preference in memory for positive over negative images, and elderly participants were far more likely to recall positive images than negative. Now called the *positivity effect*, the pattern we observed refers to a shift from a negativity bias early in life to a positivity bias that emerges in middle and late adulthood.

At this point, the positivity effect has been widely documented: it has been observed in visual attention (Sasse, Gamer, Büchel, & Brassen, 2014), short-term memory (Mammarella, Di Domenico, Palumbo, & Fairfield, 2016), autobiographical memory (Kennedy, Mather, & Carstensen, 2004), and even working memory (Mikels, Larkin, Reuter-Lorenz, & Carstensen, 2005). The effect has been documented in attention to emotional faces (Fischer et al., 2005; Mather & Carstensen, 2003), memory for health information (English & Carstensen, 2015), and in the interpretation of socially ambiguous situations (Mikels & Shuster, 2016). A meta-analysis based on 100 studies concluded that the positivity effect was reliable and robust (Reed, Chan, & Mikels, 2014).

Despite many replications, a small number of high-quality studies did not replicate the effects (e.g. Grühn, Smith, & Baltes, 2005). In some cases, the researchers used the same stimuli we had used in our studies, so these results were particularly intriguing to us. Andy Reed and I systematically compared the methods used in failures to replicate with methods in studies that revealed the effect. Virtually all of the failures to replicate included explicit instructions for participants to operate on the stimuli in a specific manner (Reed & Carstensen, 2012). We suspect that instructions to process experimental stimuli supersede chronically activated goals about emotional meaning and satisfaction. In the subsequent Reed et al. (2014) metaanalysis, findings showed that the positivity effect is most pronounced in studies in which cognitive processing is not constrained, and is weakest in studies that include experimental goals.

Reasonable alternative explanations for the mechanisms posited by SST have also been raised. Cacioppo, Berntson, Bechara, Tranel, and Hawkley (2011) argued that decreased activation to negative stimuli may reflect neural degeneration. Similarly, others argued that positive information may be easier to process than negative information (Labouvie-Vief, Grühn, & Studer, 2010). Examining these possibilities helped to clarify the phenomenon. Mather led much of this work using neuroimaging to gain essential insights into mechanisms underlying the positivity effect: in a study where participants viewed IAPS images while in a brain scanner, amygdala activation was selectively diminished in response to negative stimuli, whereas there were no age differences in response to positive (Mather et al., 2004) or novel stimuli (Wright, Wedig, Williams, Rauch, & Albert, 2006). Classic cognitive paradigms also proved useful in resolving alternatives. Mather and Knight (2005) published a set of studies that ruled out cognitive decline as responsible for the positivity effect. In the first study, they found that positivity is strongest in people with high levels of executive function and weakest in those with low levels of executive function. In a second study, which utilised a dualattention task, they observed that the effect is diminished as cognitive demands are increased. Together, these findings provide strong evidence that positivity reflects top down processing related to cognitive control as opposed to neural or cognitive degradation.

Looking forward

The field has changed in so many ways over the past 30 years. There is now relatively less space between affective and cognitive science, and I believe that this integration reflects our progress in understanding the mind, brain, and emotion. My own research programme, which began by addressing a paradox of aging, led to insights about the ability to selectively allocate cognitive resources that contribute to emotional resilience and well-being. While there are some well-documented declines associated with aging, the presumption that aging is synonymous with decline is clearly wrong.

One of the advantages of growing older is that you can see developments that unfold over years and decades that are largely impossible to recognise when you are in the midst of change. Writing the present essay provoked many memories, and I repeatedly had the sense of a pendulum swinging. Over the past few decades, certain subject matter at the heart of psychology was rejected as ill-suited for scientific study – whether it was the study of mental processes during the time of behaviourism or the study of emotion during the cognitive revolution. As time went on, these studies and ways of thinking came to be accepted by the field as a whole.

I believe that there is another pendulum swinging today involving reproducibility. Historically, the field was far too remiss in accepting findings from single laboratories and proceeding as if they were established truths. Psychology wasn't taking itself sufficiently seriously. Scrutinising findings was somehow "impolite." Yet, of course, *any* findings that are important must be scrutinised. I believe that NIH should establish new vehicles – by establishing an Institute of Replicability or by funding mechanisms aimed at the same goals – where important findings are reproduced and replicated by independent groups of investigators. If we are to build the science, the body of literature we generate must be must be rigorously tested.

In this future scenario, serious questioning of a research team's findings will reflect respect for the potential importance of the finding – not the unfortunate "gotcha" approach that is too prevalent today. I know too many junior scientists who are afraid they will make a mistake or overlook an alternate explanation for their results and that this will somehow reflect on their character as scientists. Instead of striving to always be right, we should relish pursuits about how we are wrong (see Klein et al., 2018). In my research on the positivity effect, we benefitted tremendously from fastidious examinations of studies that failed to replicate the core effect.

My advice to junior researchers: challenge your most basic assumptions. Continually question yourself and question the most widely held assumptions in the field. Embrace open science. Register your hypotheses and make your data available. Pilot, pilot, and pilot some more. Have fun. Don't hold back on publishing until you are certain you are right. Instead, be open to being wrong. When people ask you if you are certain, reply, "Hell, no." And when you try and try again to capture an expected phenomenon and fail, recognise that you may be on the trail of something really important. Gather more information, more insights, and go back to the lab. My father, Edwin Carstensen, a distinguished biophysicist, once

wrote: “The tentative nature of science does not speak against science. It is science.” Finding out *how* we are wrong is the surest way to move closer to the truth.

The future of psychology is bright. We are on the brink of scores of new technologies that will allow us to see phenomena at the microscopic level and also to see patterns, currently undetectable, in macrolevel behavioural data. Novel analytic methods will lead to additional breakthroughs. I believe that as we move forward we will continue to witness a dissolving of the boundaries that separate the classic subareas of psychology. Just as this kind of integration led to breakthroughs in emotion and cognition, further integration will allow us to more deeply understand human behaviour. Thirty years from now, we will look back and see the many ways we were wrong today.

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References

Anderson JR, & Bower GH (1974). A propositional theory of recognition memory. Memory & Cognition, 2(3), 406–412. doi:10.3758/BF03196896 [PubMed: 21274765]

Baumeister RF, Bratslavsky E, Finkenauer C, & Vohs KD (2001). Bad is stronger than good. Review of General Psychology, 5(4), 323–370. doi:10.1037/1089-2680.5.4.323

Berenbaum H, & Oltmanns TF (1992). Emotional experience and expression in schizophrenia and depression. Journal of Abnormal Psychology, 101(1), 37–44. doi:10.1037/0021-843X.101.1.37 [PubMed: 1537971]

Butzlaff RL, & Hooley JM (1998). Expressed emotion and psychiatric relapse: A meta-analysis. Archives of General Psychiatry, 55(6), 547–552. doi:10.1001/archpsyc.55.6.547 [PubMed: 9633674]

Cacioppo JT, Berntson GG, Bechara A, Tranel D, & Hawkley LC (2011). Could an aging brain contribute to subjective well-being? The value added by a social neuroscience perspective In Todorov A, Fiske ST, & Prentice DA (Eds.), Social neuroscience: Toward understanding the underpinnings of the social mind (pp. 249–262). New York: Oxford University Press. doi:10.1093/acprof:oso/9780195316872.003.0017

Cacioppo JT, Martzke JS, Petty RE, & Tassinary LG (1988). Specific forms of facial EMG response index emotions during an interview: From Darwin to the continuous flow hypothesis of affect-laden information processing. Journal of Personality and Social Psychology, 54(4), 592–604. doi:10.1037/0022-3514.54.4.592 [PubMed: 3367281]

Carstensen LL (1992). Social and emotional patterns in adulthood: Support for socioemotional selectivity theory. Psychology and Aging, 7(3), 331–338. doi:10.1037/0882-7974.7.3.331 [PubMed: 1388852]

Carstensen LL (2006). The influence of a sense of time on human development. Science, 312(5782), 1913–1915. doi:10.1126/science.1127488 [PubMed: 16809530]

Carstensen LL, Isaacowitz DM, & Charles ST (1999). Taking time seriously: A theory of socioemotional selectivity. American Psychologist, 54(3), 165–181. doi:10.1037/0003-066X.54.3.165 [PubMed: 10199217]

Carstensen LL, & Turk-Charles S (1994). The salience of emotion across the adult life span. Psychology and Aging, 9 (2), 259–264. doi:10.1037/0882-7974.9.2.259 [PubMed: 8054174]

Charles ST, Mather MM, & Carstensen LL (2003). Aging and emotional memory: The forgettable nature of negative images for older adults. Journal of Experimental Psychology: General, 132(2>), 310–324. doi:10.1037/0096-3445.132.2.310 [PubMed: 12825643]

Cooper LA, & Shepard RN (1975). Mental transformation in the identification of left and right hands. Journal of Experimental Psychology: Human Perception and Performance, 1(1), 48–56. doi:10.1037/0096-1523.1.1.48

Davidson RJ, Ekman P, Saron CD, Senulis JA, & Friesen WV (1990). Approach-withdrawal and cerebral asymmetry: Emotional expression and brain physiology: I. Journal of Personality and Social Psychology, 58(2), 330–341. doi:10.1037/0022-3514.58.2.330 [PubMed: 2319445]

Ekman P, & Friesen WV (1978). Manual for the facial action coding system. Palo Alto, CA: Consulting Psychologists Press.

Ekman P, Levenson RW, & Friesen WV (1983). Autonomic nervous system activity distinguishes among emotions. Science, 221(4616), 1208–1210. doi:10.1126/science.6612338 [PubMed: 6612338]

English T, & Carstensen LL (2015). Does positivity operate when the stakes are high? Health status and decision making among older adults. Psychology and Aging, 30(2), 348–355. doi:10.1037/a0039121 [PubMed: 25894484]

Fischer H, Sandblom J, Gavazzeni J, Fransson P, Wright CI, & Backman L (2005). Age-differential patterns of brain activation during perception of angry faces. Neuroscience Letters, 386(2), 99–104. doi:10.1016/j.neulet.2005.06.002 [PubMed: 15993537]

Fung HH, & Carstensen LL (2003). Sending memorable messages to the old: Age differences in preferences and memory for advertisements. Journal of Personality and Social Psychology, 85(1), 163–178. doi:10.1037/0022-3514.85.1.163 [PubMed: 12872892]

Gotlib IH, & McCann CD (1984). Construct accessibility and depression: An examination of cognitive and affective factors. Journal of Personality and Social Psychology, 47(2), 427–439. doi:10.1037/0022-3514.47.2.427 [PubMed: 6481620]

Grühn D, Smith J, & Baltes PB (2005). No aging bias favoring memory for positive material: Evidence from a heterogeneity-homogeneity list paradigm using emotionally toned words. Psychology and Aging, 20(4), 579–588. doi:10.1037/0882-7974.20.4.579 [PubMed: 16420133]

Kennedy Q, Mather M, & Carstensen LL (2004). The role of motivation in the age-related positivity effect in autobiographical memory. Psychological Science, 15(3), 208–214. doi:10.1111/j.0956-7976.2004.01503011.x [PubMed: 15016294]

Kiecolt-Glaser JK, & Glaser R (1992). Psychoneuroimmunology: Can psychological interventions modulate immunity? Journal of Consulting and Clinical Psychology, 60(4), 569–575. doi:10.1037/0022-006X.60.4.569 [PubMed: 1506504]

Klein O, Hardwicke TE, Aust F, Breuer J, Danielsson H, Mohr AH, … Frank MC (2018). A practical guide for transparency in psychological science. Collabra: Psychology, 4(1), 20. doi:10.1525/collabra.158

Labouvie-Vief G, Grühn D, & Studer J (2010). Dynamic integration of emotion and cognition: Equilibrium regulation in development and aging In Lerner RM & Freund AM (Eds.), The handbook of life-span development (Vol. 2, pp. 79–115). Hoboken, NJ: John Wiley & Sons, Inc. doi:10.1002/9780470880166.hlsd002004

Lazarus RS (1984). On the primacy of cognition. American Psychologist, 39(2), 124–129. doi:10.1037/0003-066X.39.2.124

Levenson RW (1992). Autonomic nervous system differences among emotions. Psychological Science, 3(1), 23–27. doi:10.1111/j.1467-9280.1992.tb00251.x

MacLeod C, Mathews A, & Tata P (1986). Attentional bias in emotional disorders. Journal of Abnormal Psychology, 95(1), 15–20. doi:10.1037/0021-843X.95.1.15 [PubMed: 3700842]

Mammarella N, Di Domenico A, Palumbo R, & Fairfield B (2016). When green is positive and red is negative: Aging and the influence of color on emotional memories. Psychology of Aging, 31, 914–926. doi:10.1037/pag0000122

Mather M, Canli T, English T, Whitfield S, Wais P, Ochsner K, … Carstensen LL (2004). Amygdala responses to emotionally valenced stimuli in older and younger adults. Psychological Science, 15(4), 259–263. doi:10.1111/j.0956-7976.2004.00662.x [PubMed: 15043644]

Mather M, & Carstensen LL (2003). Aging and attentional biases for emotional faces. Psychological Science, 14(5), 409–415. doi:10.1111/1467-9280.01455 [PubMed: 12930469]

Mather M, & Knight M (2005). Goal-directed memory: The role of cognitive control in older adults' emotional memory. Psychology and Aging, 20(4), 554–570. doi:10.1037/0882-7974.20.4.554 [PubMed: 16420131]

Mikels JA, Larkin GL, Reuter-Lorenz PA, & Carstensen LL (2005). Divergent trajectories in the aging mind: Changes in working memory for affective versus visual information with age. Psychology and Aging, 20(4), 542–553. doi:10.1037/0882-7974.20.4.542 [PubMed: 16420130]

Mikels JA, & Shuster MM (2016). The interpretative lenses of older adults are not rose-colored—just less dark: Aging and the interpretation of ambiguous scenarios. Emotion, 16(1), 94–100. doi: 10.1037/emo0000104 [PubMed: 26322570]

Reed AE, & Carstensen LL (2012). The theory behind the age-related positivity effect. Frontiers in Psychology, 3, 1–9. doi:10.3389/fpsyg.2012.00339 [PubMed: 22279440]

Reed AE, Chan L, & Mikels JA (2014). Meta-analysis of the age-related positivity effect: Age differences in preferences for positive over negative information. Psychology and Aging, 29(1), 1–15. doi:10.1037/a0035194 [PubMed: 24660792]

Sasse LK, Gamer M, Büchel C, & Brassen S (2014). Selective control of attention supports the positivity effect in aging. PLoS ONE, 9(8), e104180. doi:10.1371/journal.pone.0104180 [PubMed: 25093459]

Schacter DL (1987). Implicit memory: History and current status. Journal of Experimental Psychology: Learning, Memory, and Cognition, 13(3), 501–518. doi:10.1037/0278-7393.13.3.501

Tversky A, & Kahneman D (1983). Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment. Psychological Review, 90(4), 293–315. doi:10.1037/0033-295X.90.4.293

Wright CI, Wedig MM, Williams D, Rauch SL, & Albert MS (2006). Novel fearful faces activate the amygdala in healthy young and elderly adults. Neurobiology of Aging, 27(2), 361–374. doi: 10.1016/j.neurobiolaging.2005.01.014 [PubMed: 16399218]

Zajonc RB (1984). On the primacy of affect. American Psychologist, 39(2), 117–123. doi: 10.1037/0003-066X.39.2.117