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Executive Functioning and Nontarget Emotions in Late Life

Jacquelyn E. Stephens[1], David B. Rompilla, Jr.[1], Emily F. Hittner[1], Vijay A. Mittal[2, 3, 4, 5, 6], and Claudia M. Haase[1, 2]

[1] School of Education and Social Policy, Northwestern University
[2] Department of Psychology, Northwestern University
[3] Department of Psychiatry, Northwestern University
[4] Medical Social Sciences, Northwestern University
[5] Institute for Policy Research (IPR), Northwestern University
[6] Institute for Innovations in Developmental Sciences (DevSci), Northwestern University

When confronted with an emotion prototype (e.g., loss), individuals may experience not only target emotions (e.g., sadness), but also nontarget emotions (emotions that are atypical or incongruent with an emotion prototype; e.g., gratitude in response to loss). What are the cognitive correlates of nontarget emotions? Drawing from models of emotion generation, the present laboratory-based study examined associations between aspects of executive functioning (i.e., working memory, inhibition, verbal fluency) and the subjective experience of positive and negative nontarget emotions in response to sad and awe film clips in 129 healthy older adults. Findings showed that (a) lower working memory was associated with higher levels of positive and negative nontarget (but not target) emotions in response to sad and awe film clips. Moreover, (b) associations were specific to working memory and not found for other aspects of executive functioning. Associations were (c) robust when accounting for age, gender, education, target emotion and physiological arousal (except for negative nontarget emotions in response to the sad film clips). Finally, (d) findings were driven by awe, happiness, calm, and gratitude for the sad film clips and disgust, fear, sadness, compassion, happiness, love, and excitement for the awe film clips. Overall, these findings show a link between lower working memory function and elevated nontarget emotional experiences in late life. Directions for future research are discussed.

Keywords: working memory, nontarget emotions, emotional experience, positive emotions, aging

In response to emotion prototypes (e.g., loss), many individuals will experience the corresponding target emotion (e.g., sadness in response to loss; Kunzmann & Isaacowitz, 2017; Lazarus, 1991; Levenson, 1999). At the same time, individuals may also experience a range of other emotions, such as fear or gratitude (Hanich et al., 2014; Rottenberg et al., 2007). These *nontarget emotions,* which can be defined as emotions that are atypical or incongruent with a given emotion antecedent or prototype (Chen et al., 2021; Chen, Lwi, et al., 2017; Chen, Wells, et al., 2017), have received increasing attention in recent years, but little is known about their cognitive functioning correlates. Drawing from models of emotion generation (e.g., Levenson, 1999); mixed emotions research (e.g., Charles et al., 2017); and findings from patients with neurodegeneration and psychopathology (e.g., Chen, Lwi, et al., 2017; Sanchez et al., 2014), the present laboratory-based study examined links between executive functioning and nontarget emotions in response to film clips designed to elicit sadness and awe in healthy older adults.

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Jacquelyn E. Stephens https://orcid.org/0000-0003-2303-314X
Claudia M. Haase https://orcid.org/0000-0002-0122-9507
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Correspondence concerning this article should be addressed to Claudia M. Haase, School of Education and Social Policy, Northwestern University, Annenberg Hall, 2120 Campus Drive, Evanston, IL 60208, United States. Email: claudia.haase@northwestern.edu

What Are Nontarget Emotions?

Laboratory studies of emotion often use stimuli (e.g., film clips) that present specific emotion prototypes in order to elicit target emotions (Coan & Allen, 2007; Gross & Levenson, 1995). However, these stimuli may also elicit nontarget emotions. For example, a film clip depicting a doctor telling a woman that her husband suffered severe injuries and her two daughters have died in a car accident is designed to elicit sadness (i.e., as a response to loss). However, individuals may also experience nontarget emotions in response to more peripheral or irrelevant information in the film clip, for example, fear (e.g., because the woman receives an alarming phone call) or even gratitude (e.g., because the woman is not alone when she receives the message; Gross & Levenson, 1995; Hanich et al., 2014; Rottenberg et al., 2007).

Affective scientists have long been interested in how individuals generate *target* emotions in response to prototypical emotion antecedents (e.g., Gross, 1998; Levenson, 1999; Ochsner & Gross, 2005; Panksepp, 1982); which are considered to be evolutionarily adaptive. Yet, in recent years, researchers have become increasingly interested in how individuals generate *nontarget emotions* in these contexts (Chen et al., 2021; Chen, Lwi, et al., 2017; Chen, Wells, et al., 2017). [1] While an emerging body of research has documented the existence of nontarget emotional experiences (Chen, Lwi, et al., 2017; Chen, Wells, et al., 2017; Larsen & McGraw, 2014; Sanchez et al., 2014), we know little about their cognitive correlates.

Executive Functioning and Nontarget Emotional Experiences

Predictions From Functionalist Models of Emotion Generation

In functionalist models of emotion generation (e.g., Levenson, 1999; see also Ekman, 1992; Lazarus, 1991; Panksepp, 1998; Tooby & Cosmides, 1990); emotions are thought to arise as individuals scan incoming information (e.g., a film clip depicting a woman learning about the death of her daughters), match information to an emotion prototype (e.g., loss), and recruit prototype-matching response tendencies that give rise to the conscious experience of an emotion (e.g., sadness). Thus, if in the stream of perceived events the requirements for the prototype for "loss" are met, sadness is thought to be the target emotion elicited (see also Scherer et al., 2001). However, many emotional stimuli (e.g., film clips) are more complex and may have peripheral irrelevant information that can also be matched to prototypes (e.g., threat, benefit) giving rise to nontarget emotion (e.g., fear, gratitude).

What makes some individuals more likely than others to experience nontarget emotions? Drawing from functionalist models of emotion generation (e.g., Levenson, 1999) and longstanding debates notwithstanding (Barrett, 2006; Lazarus, 1991; Zajonc, 1980); one of the reasons may lie in individual differences in executive functioning, with working memory as a key candidate. Working memory allows individuals to mentally hold and manipulate incoming information and to correctly discriminate between relevant and less relevant information (Diamond, 2013; Unsworth & Engle, 2007). Thus, when watching an emotion-eliciting film clip, working memory may allow individuals to scan incoming information, discriminate between more relevant and less relevant information (e.g., loss vs. threat), match the more relevant information to an emotion prototype (e.g., loss), and experience target (but not nontarget) emotions. Viewed from this perspective, lower levels of working memory functioning may give rise to the experience of nontarget emotions.

Predictions From Mixed Emotions Research

Another line of work on mixed emotions can be thought of as arriving at the opposite prediction (Charles et al., 2017). Viewed from this perspective, nontarget emotions belong to a broader family of mixed emotions, which can be defined as "transient feeling states that involve two opposite affects" (Berrios et al., 2015). Although there is some debate about whether emotional expressions can coexist (Larsen & McGraw, 2014); there is convincing evidence that positive and negative emotional *experiences* (e.g., sadness and happiness; Berrios et al., 2015) can occur simultaneously, especially following bittersweet or emotionally ambiguous situations (Larsen & McGraw, 2011; Larsen et al., 2001). A wealth of research (often using experience sampling studies) has shown that mixed emotional experiences (and related aspects, such as emotion differentiation and emotional complexity) are associated with a host of beneficial psychological and physical health outcomes (Berrios et al., 2018; Erbas et al., 2014, 2016; Ong et al., 2018; Quoidbach et al., 2014). More recently, Charles and colleagues (2017) proposed that mixed emotional experiences would also be related to higher levels of cognitive functioning (see also Labouvie-Vief, 2015). Viewed from this perspective, individuals experience mixed emotions when they can look at a situation from different perspectives and have the necessary cognitive ability to integrate disparate emotional experiences together, suggesting that higher levels of executive functioning may give rise to higher levels of mixed emotions, including nontarget emotions.

Empirical Findings

There is limited work on how different aspects of executive functioning—we focus here on working memory, inhibition, and verbal fluency following Diamond (2013) – are associated with nontarget emotions, and findings are quite mixed. In healthy samples, studies indicate that individuals with a richer emotional vocabulary may describe their experiences with greater complexity and use more emotion descriptors to identify their feelings (Labouvie-Vief, 2015). This would suggest a positive link between executive functioning, specifically, verbal fluency, and nontarget emotional experiences. However, in samples of patients with neurodegeneration (e.g., Chen, Lwi, et al., 2017) and psychopathology (e.g., Aaron et al., 2018; Cohen & Minor, 2010; Kring & Elis, 2013); findings hint toward a negative link between executive functioning and nontarget emotional experiences. Specifically, heightened nontarget emotional experiences have been documented in these patient populations that are all characterized by cognitive vulnerability. For example, Chen, Lwi, et al. (2017) showed that people with Alzheimer's disease experienced greater positive nontarget emotions in response to sad, disgust, and amusement-eliciting film clips and people with

[1] Nontarget emotions share similarities with *mixed emotions* (Berrios et al., 2015; Ong et al., 2018) as both represent more complex types of emotional responding, but there are also important differences. Specifically, nontarget emotions are typically studied in laboratory-based settings in response to brief emotion prototypes (e.g., in response to loss-themed film clips), whereas mixed emotions are typically studied in everyday settings (e.g., via experience sample methods). Moreover, nontarget emotions consider positive and negative emotions separately, whereas mixed emotions, by definition, account for both (Grossmann & Ellsworth, 2017). We return to this distinction in the Discussion.

frontotemporal dementia experienced greater positive and negative nontarget emotions in comparison to healthy control groups. Nontarget emotional experiences have also been widely documented in people with schizophrenia (Cohen & Minor, 2010; Kring & Elis, 2013; Mote & Kring, 2019; Sanchez et al., 2014) who are also known to present with executive dysfunction (Elvevag & Goldberg, 2000). Even more directly relevant for the present study, in patients with schizophrenia, links have been found between lower levels of cognitive functioning and heightened levels of nontarget emotion (defined as situationally-incongruent negative emotion; Sanchez et al., 2014).

Further Considerations

Conceptual models arrive at different predictions and empirical findings regarding the link between working memory and nontarget emotional experiences are sparse. Moreover, this link has rarely been examined in healthy older adults and we know little about generalizability across different aspects of executive functioning and different nontarget emotions.

Healthy Older Adults

Existing laboratory-based research on nontarget emotions has rarely studied healthy individuals and often examined individuals with neurodegeneration (e.g., Alzheimer's Disease; Chen, Lwi, et al., 2017; Chen, Wells, et al., 2017) or psychopathology (Mote & Kring, 2019; Sanchez et al., 2014). Undoubtedly, these are important populations to study; at the same time, they present with neurological or psychiatric symptoms (e.g., broader affective dysfunction, Bungener et al., 1996) that may have confounding effects. Healthy older adults present a sample case to study links between executive functioning and nontarget emotions because they (a) do not present with clinical neurological or psychiatric symptoms that may have potentially confounding effects and (b) experience age-related cognitive decline (e.g., Salthouse, 2004) while at the same time exhibiting substantial variability in cognitive performance (Park & Festini, 2017). Moreover, and interestingly, (c) older adults are also known to experienced heightened levels of mixed emotions compared to younger adults (Carstensen et al., 2000; Ersner-Hershfield et al., 2008; Ong & Bergeman, 2004).

Generalizability Across Executive Functioning Domains

Executive functioning is not a single entity (e.g., Diamond, 2013; Salthouse, 2004) and it is unclear whether a possible link between working memory and nontarget emotions would generalize across other aspects of executive functioning. Sanchez et al. (2014) found a significant relationship between a general composite from a neurocognitive battery and nontarget emotions in schizophrenia patients, but did not test this link for specific aspects of cognitive functioning. Based on models of emotion generation and prior research (e.g., Chen, Lwi, et al., 2017; Chen, Wells, et al., 2017; Levenson, 1999), we expected a link between nontarget emotional experiences and working memory, but not necessarily other aspects of executive functioning, which are also implicated in emotional functioning (Gyurak et al., 2009, 2012; Joormann & Gotlib, 2010); including *inhibition* (i.e., the ability to prevent automatic thoughts or behaviors, Noreen & MacLeod, 2015) and *verbal fluency* (i.e., an indicator of verbal and executive control, Shao et al., 2014). Working memory, inhibition, and verbal fluency (as an aspect of cognitive flexibility) are key aspects of executive functioning (Diamond, 2013). Yet, studies show that inhibition and verbal fluency may be more relevant to emotion *regulation* rather than emotion *generation* (cf. Gyurak et al., 2009, 2012), raising the possibility that these aspects of executive functioning may be less relevant to the generation of nontarget emotional experiences.

Generalizability Across Positive and Negative Nontarget Emotions

Not all emotions are created equal and it is unclear whether a link between working memory and nontarget emotions may generalize across positive as well as negative nontarget emotions. There is a long line of work showing that the generation of positive (nontarget) emotions in the midst of stress and adversity is linked to higher psychological functioning (e.g., Bonanno & Keltner, 1997; Folkman & Moskowitz, 2000). In contrast, the generation of negative (nontarget) emotion in response to positive stimuli seems to be a hallmark of a number of psychopathologies, such as schizophrenia (Kring & Elis, 2013; Mote & Kring, 2019). From this perspective, positive and negative nontarget emotions could exhibit differential links with executive functioning. To be clear, however, existing research with individuals with neurodegenerative diseases has demonstrated heightened levels of both positive and negative nontarget emotions (Chen, Lwi, et al., 2017) and there are similar indications from psychopathology research (Kring & Elis, 2013; Mote & Kring, 2019; Sanchez et al., 2014).

The Present Study

The present laboratory-based study examined associations between executive functioning and nontarget emotional experiences in healthy older adults. Drawing from prior research (Chen et al., 2021; Chen, Lwi, et al., 2017; Cohen & Minor, 2010; Sanchez et al., 2014), we hypothesized that lower levels of executive functioning, specifically working memory, would be associated with greater positive and negative nontarget emotional experiences in response to sad and awe film clips.

Several design features of the present study are noteworthy. First, we tested our hypothesis in a sample of healthy older adults in order to (a) be able to observe sizable variation in working memory performance (Park & Festini, 2017) while at the same time (b) exclude confounding conditions (i.e., dementia, depression, alcoholism, etc.). Second, to probe generalizability across nontarget emotions, we examined both positive and negative nontarget emotions in response to film clips designed to elicit sadness, building on prior work (Chen, Lwi, et al., 2017; Chen, Wells, et al., 2017) and film clips designed to elicit awe (Keltner & Haidt, 2003). Third, we focused on working memory (i.e., holding information in mind and mentally working with it; Diamond, 2013) in order to target a core aspect of executive functioning critical for processing information that may give rise to emotional experiences (Levenson, 1999; Scherer et al., 2001). To determine generalizability, we also examined associations with inhibition and verbal fluency as common aspects of executive functioning (Diamond, 2013). Moreover, we probed robustness of our findings when controlling for age, gender, education, target emotions (to account for individual differences in emotional responding; e.g., Chen, Lwi, et al., 2017), and physiological arousal (to determine whether findings would be specific to emotional experiences or also emerge for other aspects of emotional responding, cf. Chen, Lwi, et al., 2017; Haase et al., 2012). In follow-up analyses, we examined associations between working memory and (a) individual nontarget emotions as well as (b) target emotions (sadness and awe, respectively) to further probe generalizability. The present study utilized data from a larger research project from which other findings have been reported previously (Rompilla et al., 2021). Links between executive functioning and emotional responding have not been analyzed previously.

Method

Participants and Procedure

Participants included 129 healthy older adults recruited from the greater Chicago area (age in years: M = 71.56; SD = 4.42, range: 64–83; 53% female; 80% White; 85% had earned at least a bachelor's degree). Analyses using GPower showed that this sample size allowed for detecting small-to-medium effects (f^2 = .20) at an alpha level of .05 with statistical power of .95 (Faul et al., 2007). Participants were excluded if they scored below 16 on the Adult Lifestyle Functional Interview-Mini Mental State Examination (Mini-MMSE; Roccaforte et al., 1992); scored above 17 on the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977); scored above 3 on the short Michigan Alcoholism Screening Test - Geriatric Version (MAST; Selzer, 1971); or had any vision or hearing issues that would impair their ability to complete the study. Recruitment occurred by advertising and contacting participants on participant registries, posting on online forums, reaching out to senior citizen communities and organizations, flyering in frequented areas, and referrals from other participants. The study was approved by the Northwestern University IRB and participants were compensated $60.

Participants were seated across from a 40-in. TV screen and attached to noninvasive sensors that measured their physiology. At the beginning of the study (i.e., at baseline), they completed an emotion checklist measuring their emotions "right now." They then completed six experimental trials in which they (a) practiced an executive function task; (b) rested for one minute while watching an "X"; (c) watched a film clip depicting loss under reactivity or regulation instructions (See Appendix A); (d) rated their emotional experiences in response to the film clip; and (e) completed the executive function task they had practiced. Moreover, they completed two experimental trials (without executive function tasks) in which they (a) rested for one minute while watching an "X"; (b) watched a film clip depicting natural beauty or a shift in perspective; and (c) rated their emotional experiences in response to the film clip. Film clips, instructions, emotion checklists, and cognitive tasks were presented using the software Psychopy (Peirce, 2007). Participants submitted their answers to the emotion checklist and to the executive function tasks using a large-print wireless keyboard arranged on a portable tray in front of their chair.

All six film clips depicting loss (ranging from 86 s to 201 s) had been validated to elicit sadness in prior research, and included excerpts from (a) *Titanic* (Wang et al., 2006); (b) *Champ* (Gross & Levenson, 1995); (c) *Terms of Endearment* (Wang et al., 2006); (d) *Fatal Attraction* (Davis et al., 2014); (e) *21 Grams* (Shiota & Levenson, 2009); and (f) *The Notebook* (Kim, 2013). In the reactivity trials, half of participants watched *Titanic, Champ,* and *Terms of Endearment* (in fixed order), while the other half watched *Fatal Attraction, 21 Grams,* and *The Notebook* (in fixed order). The reactivity trials were always presented before the regulation trials in order to obtain a measure of emotional reactivity before participants received any instructions to regulate their emotions (Gyurak et al., 2009). The two film clips depicting natural beauty and a shift in perspective were validated to elicit awe (Keltner & Haidt, 2003) and included excerpts from (a) *Planet Earth* (Valdesolo & Graham, 2014) and (b) a YouTube video depicting colored water droplets colliding with milk in slow motion (Piff et al., 2015) and were presented in this order.

Measures

Executive Functioning

Executive functioning (EF) was measured by three working memory tasks, two inhibition tasks, and one verbal fluency task. These tasks have been used widely in prior research and there exists a large literature probing their construct validity and psychometric properties (for a review see Diamond, 2013). Tasks took about one to two minutes to complete (except for verbal fluency, which consisted of three trials that lasted one minute each). Each EF task was paired with a specific film clip (e.g., verbal fluency occurred after Titanic). EF task-film clip pairs were then counterbalanced between reactivity and regulation trials, by splitting them into two groups (1: Titanic-Verbal Fluency, Champ-Stroop, Terms of Endearment-Simon Effect; 2: Fatal Attraction-Digit Span, 21 Grams-Corsi Block, Notebook-Adaptive Digit Ordering), such that half of the sample watched and completed the first set of film clips/EF tasks in the reactivity trials and the second set of film clips/EF tasks in the regulation trials (and vice versa). Participants completed a practice trial for all EF tasks to ensure that they understood the instructions (see Appendix B). *Working memory* was assessed using a composite of three well-established tasks. In the Adaptive Digit Ordering Test (Werheid et al., 2002); participants viewed six sets of digits of increasing length (i.e., 2–8 digits; e.g., 6, 2, 8, 3) and then were asked to recall the digits in ascending order (e.g., 2, 3, 6, 8). In the Corsi Block test (Vandierendonck et al., 2004); participants viewed six sets of squares with increasing numbers (i.e., 2–7 squares) that were highlighted or marked in a specific order and then were asked to click on the squares in the order they were highlighted. In the Forward Digit Span (Myerson et al., 2003); participants viewed series of digits of increasing length (i.e., 2–8 digits; e.g., 3, 5, 9) and were then asked to recall the digits in the order they were presented. For all working memory tasks, performance was assessed by a) correct total number of digits or squares and b) correct total number of sequences. Our analyses use the correct total number of individual digits. The working memory score was calculated by z-scoring and averaging the total number of correct responses across the three tasks (α = .66).

Inhibition was measured by the Stroop task (Stroop, 1935) and the Simon Effect task (Burle et al., 2002). For the Stroop task, participants were told that they would see color words (i.e., red, green, blue, yellow) in different color text (Beglinger et al., 2005). They were then instructed to respond with the color that matched the color of the text—not the color word itself—as quickly as possible. For the Simon Effect task, participants were told that they would see either a red or green circle on the left or right side of the screen (Burle et al., 2002). They were then asked to respond with the color that corresponds with that of the circle as quickly as possible, ignoring the circle's placement on the screen. Performance on both tasks was measured by dividing the number of total correct responses by response time (to account for overall speed and accuracy; von Hippel & Gonsalkorale, 2005). The total number of correct responses for each task were z-scored and averaged together (α = .66).

Verbal fluency was measured by the F-A-S task (Troyer et al., 1997). Participants were given 60 seconds to generate words aloud that began with a given letter that appeared on the screen (e.g., F), without naming proper nouns or repeating the same word with different endings. Performance was indicated by the z-scored mean number of words generated across the three trials.

Target and Nontarget Emotional Experiences

Emotional experiences (i.e., sadness, anger, fear, disgust, surprise, compassion, happiness, excitement, gratitude, love, calm, awe) were assessed at the beginning of the study and after each film clip (0 = *not at all*, 8 = *strongest emotion ever felt*). We analyzed (a) positive nontarget emotions (i.e., calm, excitement, gratitude, happiness, love; α = .73 [and awe when analyzing the sad film clips; and compassion when analyzing the awe film clips α = .63]) and (b) negative nontarget emotions (i.e., anger, disgust, fear; α = .79 [and sadness when analyzing the awe film clips; α = .73]).[2] Composite scores were created by averaging across emotions in the sad or awe film clips, respectively.

Covariates

Covariates included age, gender, education (i.e., "what is the highest level of education you have obtained"; 1 = less than high school/GED, 2 = high school/GED, 3 = some college, 4 = 4 years of college, 5 = Master's degree, 6 = PhD, M.D., or other professional degree), and target emotion. Moreover, we included physiological arousal as a covariate to control for individual differences in emotional responding. Physiological data were continuously measured using standard procedures (for details see Rompilla et al., 2021). Data were cleaned for artifacts by trained research assistants and corrected if necessary. As in prior work (Haase et al., 2012; Rompilla et al., 2021; Shiota & Levenson, 2009), we sampled broadly across multiple physiological channels (that is, interbeat interval [IBI], respiration rate, skin conductance [SC], respiratory sinus arrhythmia [RSA], root mean square of successive differences [RMSSD], preejection period [PEP], left ventricular ejection time [LVET], cardiac output, and stroke volume). All channels were z-scored and averaged across each respective baseline and film clip periods with select channels (i.e., IBI, RSA, RMSSD, LVET, PEP) recoded (i.e., multiplied by −1) so that higher values always represented greater physiological arousal (i.e., greater sympathetic or lower parasympathetic activation). To reduce the number of statistical tests (see, e.g., Shiota & Levenson, 2009), physiological measures were combined to obtain a measure of composite physiological arousal. Physiological arousal difference scores were then calculated separately for the sad and awe film clips by subtracting physiological arousal during the respective prefilm baseline from physiological arousal during the film clip.

Data Analyses

First, we conducted a series of preliminary analyses to (a) examine zero-order intercorrelations between key study variables and b) examine emotional experiences in response to the sad and awe film clips and confirm that they elicited the respective target emotion (by conducting repeated-measures ANOVAs comparing difference scores between baseline and reactivity for all emotions). Second, to test our hypothesis, we conducted multiple regression analyses with working memory performance as the independent variable and positive or negative nontarget emotions as dependent variables in separate regression models. We then probed generalizability across executive functioning by examining whether inhibition or verbal fluency predicted nontarget emotions in separate regression models. Moreover, we entered all executive functioning variables in the same regression model in order to determine whether working memory remained a significant predictor of nontarget emotions when controlling for the other executive functioning aspects. We probed robustness by controlling for age, gender, education, target emotion, and physiological arousal. In follow-up analyses, we examined (a) associations between working memory performance and individual nontarget emotions (each used as the independent variable in separate regression models) and (b) links between working memory and target emotions.

Results

Preliminary Analyses

Table 1 provides descriptive information and shows zero-order correlations between the key study variables. Table 2 provides descriptive information and zero-order correlations between all EF tasks. Figure 1 shows that individuals experienced high levels of the target emotion (i.e., sadness in response to the sad clips: M = 5.7, SD = 1.7; awe in response to the awe clips: M = 5.7, SD = 2.2) with substantial coactivation of compassion (in response to the sad clips) and calm (in response to the awe clips), respectively, as well as other positive nontarget emotions (in response to both sad and awe clips). Repeated-measures ANOVAs confirmed that sadness and awe increased more than other emotions from baseline to film clips ($ps < .001$), respectively.

Executive Functioning and Nontarget Emotions

Working Memory and Nontarget Emotions

Lower working memory functioning predicted higher levels of negative nontarget emotions (β = −.24, $SE[B]$ = .05, p = .009) and

[2] Surprise was not included in the nontarget composites because it is not clearly positively or negatively valenced; An et al., 2017). Compassion was excluded from analyses for the sad film clips because it is commonly co-activated in response to sad film clips and did not clearly constitute a nontarget emotion (Davis et al., 1987). Calm was excluded from analyses for the awe film clips because it was similarly co-activated in response to awe film clips and did not clearly constitute a nontarget emotion. Analyses remained stable when compassion (for the sad film clips; β = −.34, SE = .05, $p < .001$) and calm (for the awe film clips; β = −.30, SE = .05, p = .007) were included in the positive composite nontarget emotion scores. Results also remained stable when love (in addition to compassion) was excluded from the positive nontarget emotion composite for the sad film clips (β = −.36, SE = .14, $p < .001$).

Table 1
Descriptive Statistics and Intercorrelations Between Key Study Variables

Variable	*M* (or %)	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Negative NTE (sad)	1.75	1.44	—													
2. Positive NTE (sad)	2.05	1.20	.43**	—												
3. Negative NTE (awe)	.31	.67	.34**	.46**	—											
4. Positive NTE (awe)	3.51	1.74	.35**	.46**	.24*	—										
5. Sadness (sad)	5.69	1.70	.37**	.43**	.24*	.21*	—									
6. Awe (awe)	5.75	2.16	.13	.14	−.01	.58**	.26**	—								
7. Working memory	24.18	4.26	−.25**	−.38**	−.27**	−.26**	−.17	.03	—							
8. Inhibition	40.24	8.29	−.18	−.22	−.10	−.07	−.11	.07	.43**	—						
9. Verbal fluency	14.02	4.85	.12	−.13	.10	.07	−.10	.08	.16	.21*	—					
10. Age	70.67	4.42	−.08	−.16	−.02	.14	−.15	.15	−.08	−.08	.08	—				
11. Gender (female)	53%	.50	.17	−.15	.05	.06	.03	.04	−.02	.08	.13	−.05	—			
12. Education	3.60	1.03	−.20*	−.24**	−.05	−.05	−.16	.12	.28**	.26**	.30**	.26**	−.03	—		
13. Physiological arousal (sad)	−.02	.46	.14	.06	.01	.24**	.02	.16	.03	.06	.08	−.05	.06	.16	—	
14. Physiological arousal (awe)	.004	.36	.00	−.02	−.04	.14	−.03	−.003	.12	.08	.13	−.09	.05	.16	.65**	—

Note. NTE = nontarget emotions. Film clips are indicated in parentheses (sad vs. awe). Executive functioning performance is shown unstandardized (standardized scores were used in all analyses).
* $p < .05$. ** $p < .01$.

positive nontarget emotions (β = −.34, *SE*[*B*] = .05, $p < .001$) in response to the sad film clips (see Table 3, Step 1).[3] Similarly, lower working memory functioning predicted higher levels of negative nontarget emotions (β = −.25, *SE*[*B*] = .09, *p* = .005) and positive nontarget emotions (β = −.24, *SE*[*B*] = .04, *p* = .007) in response to the awe film clips (see Table 3, Step 1).[4]

Generalizability Across Executive Functioning Aspects

First, we examined executive functioning and nontarget emotions in response to the sad film clips. Lower inhibition alone predicted higher levels of negative (β = −.18, *SE*[*B*] = .05, *p* = .047) and positive (β = −.21, *SE*[*B*] = .06, *p* = .02) nontarget emotions in response to the sad film clips. Verbal fluency alone did not predict negative (β = .11, *SE*[*B*] = .07, *p* = .24) or positive (β = −.13, *SE*[*B*] = .07, *p* = .15) nontarget emotions in response to the sad film clips. In multiple regression models that included all three executive functioning aspects as independent variables (See Table 3, Step 2), working memory—but not inhibition or verbal fluency (*ps* > .05) – significantly predicted negative nontarget emotions (β = −.20, *SE*[*B*] = .19, *p* = .04) in response to the sad film clips. Similarly, lower working memory—but not inhibition or verbal fluency (*ps* > .05) – significantly predicted positive nontarget emotions (β = −.31, *SE*[*B*] = .15, *p* = .002) in response to the sad film clips.

Next, we examined executive functioning and nontarget emotions in response to the awe film clips. Neither inhibition nor verbal fluency predicted nontarget emotions in response to the awe film clips (*ps* > .05). In multiple regression models that included all three executive functioning aspects as independent variables (See Table 3, Step 2), working memory—but not inhibition or verbal fluency (*ps* > .05) – significantly predicted negative (β = −.27, *SE*[*B*] = .09, *p* = .009) and positive (β = −.22, *SE*[*B*] = .25, *p* = .03) nontarget emotions in response to the awe film clips.

Robustness

Associations between working memory and nontarget emotions remained largely stable[5] when controlling for age, gender, education, target emotion, and physiological arousal[6] in addition to inhibition and verbal fluency (see Table 3, Step 3) with one exception. The association between working memory and negative nontarget emotions in response to the sad film clips was no longer statistically significant (β = −.15, *SE*[*B*] = .05, *p* = .09; see Table 3, Step 3). Moreover, inhibition was no longer associated with negative or positive nontarget emotions after accounting for covariates (See Table 3, Step 3). Instead, a new, positive association emerged between verbal fluency and negative nontarget emotions in response to the sad film clips (β = .22, *SE*[*B*] = .05, *p* = .03; See Table 3, Step 3).

[3] Findings generalized across two of the three working memory tasks for negative nontarget emotions (Adaptive: β = −.20, *SE*[*B*] = .13, *p* = .02; Corsi: β = −.14, *SE*[*B*] = .13, *p* = .12; Digit Span: β = −.19, *SE*[*B*] = .13, *p* = .03) and for all three working memory tasks for positive nontarget emotions (Adaptive: β = −.33, *SE*[*B*] = .08, $p < .001$; Corsi: β = −.27, *SE*[*B*] = .07, *p* = .003; Digit Span: β = −.23, *SE*[*B*] = .07, *p* = .01) for the sad film clips

[4] Findings generalized across two of the three tasks for negative nontarget emotions (Adaptive: β = −.16, *SE*[*B*] = .07, *p* = .08; Corsi: β = −.18, *SE*[*B*] = .04, *p* = .04; Digit Span: β = −.22, *SE*[*B*] = .06, *p* = .01) and for one of the tasks for positive nontarget emotions (Adaptive: β = −.19, *SE*[*B*] = .17, *p* = .03, *p* = .04; Corsi: β = −.13, *SE*[*B*] = .17, p = .16; Digit Span: β = −.08, *SE*[*B*] = .17, *p* = .36) for the awe film clips.

[5] Results also remained stable when controlling for mixed emotions at baseline (calculated following procedures by Hemenover & Schimmack, 2007). For the sad film clips, lower working memory predicted positive (β = −.27, *SE*[*B*] = .14, *p* = .001), but not negative (β = −.16, *SE*[*B*] = .05, *p* = .11) nontarget emotions. For the awe film clips, working memory predicted both negative (β = −.23, *SE*[*B*] = .09, *p* = .02) and positive (β = −.18, *SE*[*B*] = .19, *p* = .02) nontarget emotions.

[6] Results also remained stable when controlling for skin conductance (SCL) or pre-ejection period (PEP) alone instead of the physiological arousal composite. Specifically, for the sad film clips, lower working memory predicted positive (SCL: β = −.28, *SE*[*B*] = .14, *p* = .001; PEP: β = −.27, *SE*[*B*] = .14, *p* = .002), but not negative (SCL: β = −.15, *SE*[*B*] = .17, *p* = .09; PEP: β = −.12, *SE*[*B*] = .17, *p* = .17) nontarget emotions when controlling for skin conductance and pre-ejection period alone, respectively. For the awe film clips, working memory predicted both negative (SCL: β = −.27, *SE*[*B*] = .09, *p* = .006; PEP: β = −.26, *SE*[*B*] = .09, *p* = .007) and positive (SCL: β = −.20, *SE*[*B*] = .19, *p* = .01; PEP: β = −.18, *SE*[*B*] = .20, *p* = .02) nontarget emotions when controlling for skin conductance and pre-ejection period alone, respectively.

Table 2
Descriptive Statistics and Intercorrelations Between Executive Functioning Tasks

Executive functioning task	*M*	*SD*	1	2	3	4	5	6	7	8
1. Adaptive digit span	23.17	5.92	—							
2. Forward digit span	28.84	5.90	.37**	—						
3. Corsi block	20.50	4.83	.38**	.42**	—					
4. Working memory composite	24.17	4.26	.77**	.79**	.74**	—				
5. Stroop task	26.50	6.57	.32**	.27**	.36**	.41**	—			
6. Simon effect	53.99	12.21	.31**	.30**	.38**	.42**	.53**	—		
7. Inhibition composite	40.24	8.29	.35**	.33**	.42**	.47**	.79**	.94**		
8. Verbal fluency	14.02	4.63	.11*	.20*	.11	.18*	.23**	.17	.22**	—

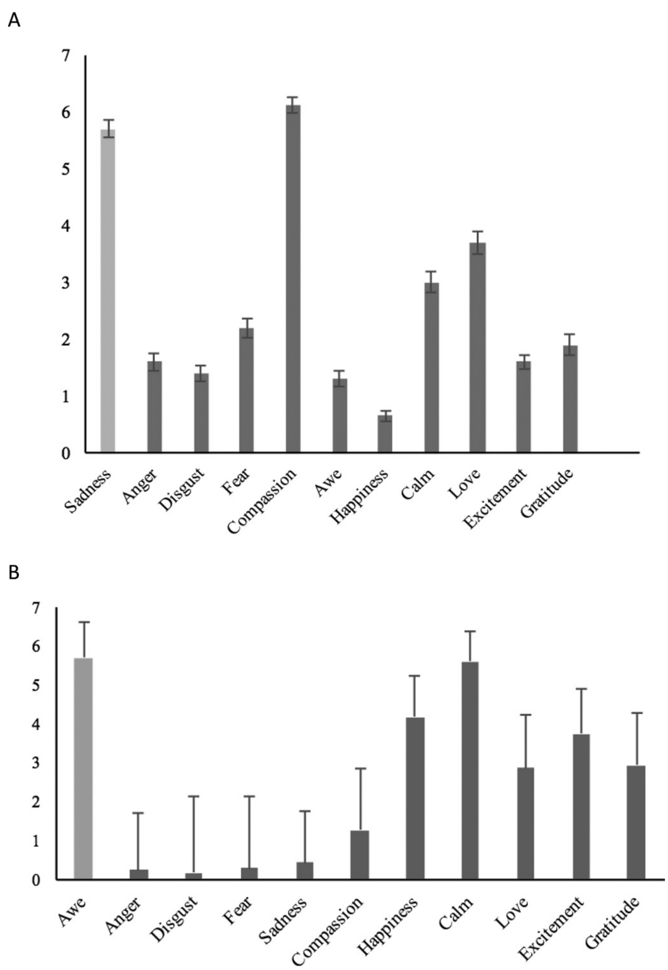
Note. Executive functioning performance is shown unstandardized (standardized scores were used in all analyses).
* $p < .05$. ** $p < .01$.

Follow-Up Analyses

Individual Nontarget Emotions

Associations with working memory were driven by four nontarget emotions for the sad clips (see Figure 2) and for seven nontarget emotions for the awe clips (see Figure 3). Specifically, in response to the sad film clips, lower working memory functioning predicted higher levels of awe (β = –.34, *SE*[*B*] = .18, $p <$ .001), happiness (β = –.32, *SE*[*B*]= .13, *p* = .001), calm (β = –.23, *SE*[*B*] = .25, *p* = .01), and gratitude (β = –.20, *SE[B]* = .27, *p* = .03),

Figure 1
Emotional Experiences in Response to Sad (A) and Awe (B) Film Clips



Note. Scores were averaged across three sad clips (A) and two awe clips (B). Error bars represent standard errors.

Table 3
Executive Functioning Performance and Nontarget Emotions

	Sad clips						Awe clips					
	Negative NTE			Positive NTE			Negative NTE			Positive NTE		
Variable	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3
Working memory	−.23*	−.20*	−.12	−.36***	−.32**	−.29**	−.27*	−.29**	−.29**	−.20*	−.23*	−.23**
Inhibition	—	−.12	−.11	—	−.06	−.03	—	−.01	−.02	—	.05	.05
Verbal fluency	—	.18	.22*	—	−.07	.01	—	.14	.15	—	.07	.04
Age	—	—	−.04	—	—	−.13	—	—	−.07	—	—	.05
Gender	—	—	.10	—	—	−.18*	—	—	.02	—	—	−.05
Education	—	—	−.17	—	—	−.08	—	—	.01	—	—	−.11
Target emotion	—	—	.33**	—	—	.36**	—	—	.00	—	—	.61***
Physiological arousal	—	—	.13	—	—	.07	—	—	−.03	—	—	.13
R^2	.05	.09	.27	.13	.14	.34	.07	.09	.10	.04	.05	.43

Note. NTE = nontarget emotions.
* $p < .05$. ** $p < .01$. *** $p < .001$.

controlling for age, gender, education, target emotion, and physiological arousal. Moreover, in response to the awe film clips, lower working memory functioning predicted higher levels of disgust (β = –.25, *SE[B]*= .10, *p* = .009), fear (β = –.19, *SE*[*B*] = .13, *p* = .048), sadness (β = –.24, *SE*[*B*] = .11, *p* = .01), compassion (β = –.20, *SE*[*B*] = .22, *p* = .03), happiness (β = –.23, *SE*[*B*] = .21, *p* = .003), love (β = –.20, *SE[B]* = .25, *p* = .02), and excitement (β = –.24, *SE[B]* = .22, *p* = .001), controlling for age, gender, education, target emotion, and physiological arousal. Lastly, associations between verbal fluency and negative nontarget emotions for the sad film clips were driven by anger (β = .23, *SE[B]* = .06, *p* = .02).

Generalizability Across Target Emotions

Findings were specific to nontarget emotions and did not generalize to target emotions. Specifically, working memory was not associated with sadness in response to the sad clips (β = –.16, *SE*[*B*] = .04, *p* = .08), nor with awe in response to the awe clips (β = .04, *SE* [*B*] = .03, *p* = .69). Inhibition and verbal fluency were also not associated with the target emotions for either set of film clips (*p*s > .05).

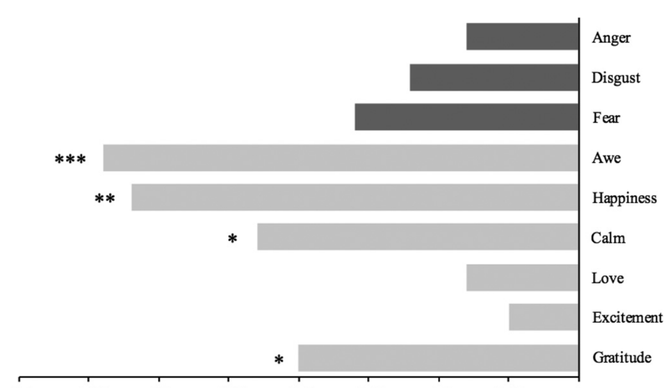
Discussion

The present study examined links between executive functioning and nontarget emotional experiences in healthy older adults. Findings showed that individuals with lower working memory experienced higher levels of nontarget (but not target) emotions in response to sad and awe film clips. These findings were specific to working memory and did not generalize across other aspects of executive functioning (i.e., inhibition, verbal fluency); in fact, individuals with higher levels of verbal fluency experienced higher levels of negative nontarget emotions in response to sad film clips when controlling for covariates. Findings were robust when controlling for age, gender, education, target emotion, and physiological arousal (except for negative nontarget emotions in response to the sad clips).

Working Memory and Nontarget Emotions

Affective science has a rich history of developing, validating, and utilizing stimuli (e.g., film clips) that present emotion prototypes or antecedents in order to elicit target emotions (Gabert-Quillen et al.,

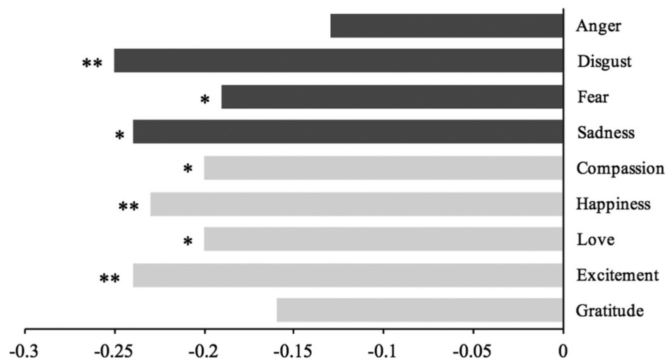
Figure 2
Working Memory Performance and Nontarget Emotions in Response to Sad Film Clips



Note. Figure shows effect sizes (standardized betas) of working memory predicting nontarget emotions controlling for age, gender, education, and target emotion.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 3

Working Memory Performance and Nontarget Emotions in Response to Awe Clips



Note. Figure shows effect sizes (standardized betas) of working memory predicting nontarget emotions controlling for age, gender, education, target emotion, and physiological arousal.
* $p < .05$. ** $p < .01$.

2015; Gross & Levenson, 1995; Rottenberg et al., 2007). At the same time, individuals do not only respond with target emotions, but often experience a range of other, nontarget emotions in response to these stimuli (e.g., Rottenberg et al., 2007). Yet, little is known about what leads individuals to generate nontarget emotional experiences.

Drawing from models of emotion generation (Levenson, 1999; Scherer et al., 2001); we examined individual differences in executive functioning as a possible source of nontarget emotions. Converging with prior research with patient samples (e.g., Sanchez et al., 2014); findings showed that healthy older adults who performed worse on well-established working memory tasks experienced higher levels of nontarget emotions in response to film clips depicting loss as well as film clips showing natural beauty or a shift in perspective. Both kinds of film clips had been designed for (Gross & Levenson, 1995) and were highly effective in eliciting the target emotions of sadness and awe, respectively. Yet, they also present other, arguably less relevant content that may give rise to other, nontarget emotions (Chen, Lwi, et al., 2017; Chen et al., 2021).

Our findings are consistent with a model of emotion generation where working memory allows individuals to scan incoming information, distinguish relevant from less relevant information, match relevant information to prototypes and experience target (but not nontarget) emotions. The present findings suggest that this process may be less intact in healthy older adults with lower levels of working memory functioning—and this may well extend to patients with neurodegeneration ((Chen, Lwi, et al., 2017; Chen, Wells, et al., 2017) and psychopathology (e.g., Kring & Elis, 2013) who present with heightened levels of nontarget emotional experiences—as well as lower levels of working memory functioning. We should add that our findings were robust for positive nontarget emotions across both sets of film clips and for negative nontarget emotions in response to awe (but not sad) film clips. Perhaps negative nontarget emotions (e.g., fear) in response to film clips depicting loss, while not exactly "on target," were still congruent with the emotion prototype of loss (e.g., a woman learning about the death of her daughters).

Another important line of research that informed the present study was mixed emotions research (Charles et al., 2017). People—especially older adults—often report mixed emotions in their daily lives (Charles, 2005; Ong & Bergeman, 2004); on the episodic level (Magai et al., 2006); and at the trait level (Ready et al., 2011). Mixed emotions research has proposed that the ability to view things from a different perspective (which, to some extent, should relate to executive functioning) should give rise to the experience of nontarget emotions. Our findings largely did not support this prediction. However, we should note that, when controlling for covariates, a positive association emerged between verbal fluency and negative nontarget emotions in response to the sad film clip, converging with predictions by mixed emotion research, findings by Labouvie-Vief (2005); and work by Erbas and colleagues (2014) that has documented the adaptive features that are associated with differentiating between negative emotions in particular. Again, more research is needed, but this suggests that verbal fluency, which indexes the ability to generate new language-based thoughts and ideas could be another source for nontarget emotions (cf. Grossmann & Ellsworth, 2017). Inhibition, on the other hand, as another aspect of executive functioning (Diamond, 2013) was not robustly associated with the experience of nontarget emotions.

Taken together, the present findings suggest that the experience of nontarget emotions could follow from lower working memory functioning where impairments in the ability to maintain, manipulate, and prioritize information could give rise to nontarget emotions. Yet, the association with verbal fluency suggests that this may not be the only route by which nontarget emotions are generated. Clearly, more research is needed to examine different pathways that may lead individuals to generate nontarget emotions.

Future Research

Executive Fuctioning and Nontarget Motions

Models of emotion generation (e.g., Levenson, 1999) suggest that impaired working memory could enhance nontarget emotional responding (e.g., Dolcos & McCarthy, 2006) and the present correlational finding support this idea. Future research could further test this idea (a) longitudinally by examining bidirectional associations between working memory and nontarget emotions and (b) experimentally by inducing cognitive load and examining effects on nontarget emotions. It is also possible that lower working memory and heightened nontarget emotions indicate broader neural decline in the form of (a) decreased segregation in brain function, which has been linked with lower memory (Chan et al., 2014) or (b) alterations in brain regions associated with perceiving and processing one's internal and external environment (e.g., insula, parahippocampal regions) which have been linked with working memory (Schon et al., 2016; Wager & Barrett, 2017) and nontarget emotions (Chen et al., 2021). Future neuroimaging studies could test these ideas. Future research could also test underlying mechanisms linking working memory and nontarget emotional experiences. Moreover, studies are needed to evaluate cognitive functioning correlates of nontarget emotions beyond those examined in the present study, notably attention (e.g., Oberauer, 2019) as well as cognitive functioning correlates of target emotions (we did not find associations in the present study).

Nontarget Versus Mixed Emotions

Mixed emotions can be defined in different ways and nontarget emotions may map onto some conceptualizations of mixed emotions (cf. Charles et al., 2017). Yet, there may also be important differences between the two constructs. Consider someone who learns about the death of a friend and later attends their funeral service. While the former situation may elicit overwhelming sadness in the moment, the latter may give rise to a range of different emotions, including not only sadness but also gratitude and amusement as memories are being shared, fear as they are reminded of their own mortality, and awe because of the transcendent nature of the experience. Thus, experiencing nontarget in the former context may be maladaptive, while experiencing mixed emotions in the latter context may well be highly adaptive (Charles et al., 2017).

Thus, another direction for future research will be to evaluate possible differences between nontarget and mixed emotions. While there is accumulating evidence showing that nontarget emotions are maladaptive (including the present findings; e.g., Chen et al., 2021; Chen, Lwi, et al., 2017; Chen, Wells, et al., 2017), there is a sizable body of research showing that mixed emotions are adaptive (Charles et al., 2017; Erbas et al., 2016; Ong et al., 2018) – and this could well be a function of the contexts in which these emotions occur (Brose et al., 2013; Davidson et al., 2000; Kunzmann & Isaacowitz, 2017; Troy et al., 2013); see also (Grossmann & Ellsworth, 2017). While nontarget emotions are typically studied in response to relatively brief stimuli that present prototypical emotion antecedents (e.g., Chen et al., 2021; Chen, Lwi, et al., 2017; Chen, Wells, et al., 2017; Mote & Kring, 2019); mixed emotions are more typically studied in everyday settings that are arguably more complex, ambiguous, and unfold over longer time intervals (e.g., Carstensen et al., 2000; Erbas et al., 2016; Ersner-Hershfield et al., 2008; Ong et al., 2018; Ong & Bergeman, 2004). Thus, future research may probe associations between cognitive functioning and nontarget (or mixed) emotions not only (a) in response to clear-cut emotion prototypes but also (b) in response to emotionally complex everyday situations (where nontarget emotions may well be adaptive). It is also possible that nontarget and mixed emotions differ in other ways, including appraisals (cf. Erbas et al., 2015), characteristics (e.g., intensity, dynamics), and real-world consequences (e.g., for well-being). Moreover, it would be interesting to examine whether individuals who respond with greater mixed emotions in everyday life also respond with greater nontarget emotions—or not—to emotion prototypes in the laboratory.

Positive Emotions Research

Our findings also have implications for positive emotions research. In the present laboratory-based study, positive nontarget emotions were linked to lower working memory functioning. Yet, positive emotions have been associated with a host of positive outcomes (Cohen & Pressman, 2006; Harker & Keltner, 2001; Sin et al., 2015); including enhanced cognitive functioning (Hittner et al., 2020; Isen, 2008) – and there is a sizable literature highlighting the benefits of positive emotions amid stress and trauma in particular (Folkman & Moskowitz, 2000; Papa & Bonanno, 2008). In some ways, one might think of positive emotions in the midst of adversity as prime examples of nontarget emotions. Yet, again, it is important to consider the different contexts. Chances are that adversity is emotionally complex and full of different prototypes that could give rise to many different emotions, including positive emotions (e.g., awe, gratitude, love). Future studies could examine links between cognitive functioning and (nontarget) positive emotions precisely in contexts of adversity.

Nonarget Emotions Across the Life Span

Finally, at a descriptive level, the present findings show that older adults responded with high levels of specific target emotions to film clips that presented prototypical emotion antecedents, building on a long line of research (Gross & Levenson, 1995; Hewig et al., 2005). At the same time, older adults also responded with substantial levels of positive nontarget emotions (see Figure 1), converging with research documented heightened levels of mixed emotions in late life (Carstensen et al., 2000, 2011; Charles et al., 2017) and a long-standing body of work documenting greater positive emotions in late life in particular (Carstensen et al., 1999; Carstensen & Mikels, 2005; Verstaen et al., 2020). It would be interesting to examine developmental trajectories of nontarget emotions across the life span both for positive as well as negative nontarget emotions.

Strengths and Limitations

The present study had several strengths, including (a) use of a sizable sample of healthy older adults; (b) use of multiple well-validated film clips designed to elicit both sadness and awe; (c) assessment of both positive and negative nontarget emotional experiences; (d) use of three well-validated tasks to assess working memory performance; and (e) implementation of robustness checks. The study also had limitations, including the (a) focus on two target emotions and lack of a neutral film clip (consistent with prior research, e.g., Chen, Lwi, et al., 2017; Chen, Wells, et al., 2017),[7] (b) focus on subjective emotional experiences; (c) focus on three aspects of executive functioning (drawing from Diamond, 2013); (d) cross-sectional study design; and (e) focus on older adults. To address these limitations, future research should (a) include film clips designed to elicit other target emotions (e.g., excitement see, Johnson et al., 2017) as well as neutral trials; (b) examine facial expressions of emotion; (c) assess other aspects of

[7] Prior research on nontarget emotions has not included neutral trials, reflecting the view that nontarget emotions (which are defined as emotions that are atypical or incongruent with a given emotion prototype), require the presence of an emotion-eliciting stimulus (e.g., Chen, Lwi, et al., 2017). However, research on mixed emotions has included neutral trials as an important comparison condition (Kreibig & Gross, 2017).

cognitive functioning (e.g., attention); (d) employ longitudinal study designs; and (e) examine healthy middle-aged and younger adults.

Conclusion

Imagine you and a loved one are watching a film clip of someone who is suffering a devastating loss. While you both experience sadness, your loved one also experiences other emotions, such as fear or gratitude, that seem quite incompatible, atypical, or incongruent with this theme of loss (Chen et al., 2021). A rapidly growing body of research has examined these nontarget emotional experiences, but few studies have elucidated what leads some individuals to generate nontarget emotions. Converging with models of emotion generation (Levenson, 1999) and expanding on prior research with patient samples (Chen et al., 2021; Chen, Lwi, et al., 2017; Chen, Wells, et al., 2017; Sanchez et al., 2014), the present study showed a link between lower working memory functioning and elevated nontarget emotions in healthy older adults. Future research will be needed to examine this link and underlying mechanisms.

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Appendix A

Reactivity and Regulation Instructions

Reactivity Trials

Instructions: You will now watch a film clip. Please pay attention while watching.

Reappraisal Trial

Instructions:

In a few slides, you will be viewing a film clip. While you are watching the film clip, we want you to try to REAPPRAISE what you are watching. Please try to think about positive aspects of what you are seeing. Watch the film clip carefully, but please try to think about what you are seeing in such a way that you feel less negative emotion.

Acceptance Trial

Instructions:

In a few slides, you will be viewing another film clip. This time, as you watch, ACCEPT your emotions. Simply let your feelings happen, whatever they may be, pleasant or unpleasant. Accept your feelings without trying to get rid of them. In other words, whatever you may experience during the film clip, just let your feelings be, and do not struggle against them. Allow yourself to experience your feelings, without judging them, and without controlling or changing them. Let your feelings run their course.

Detachment Trial

Instructions:

In a few slides, you will be viewing another film clip. While you are watching the film clip, we want you to try to DETACH from the emotional aspects of the clip. Please try to adopt a DETACHED and unemotional attitude. As you watch the film clip, please try to think about what you are seeing objectively. Watch the film clip carefully, but please try to think about what you are seeing in such a way that you feel less negative emotion.

Appendix B

Executive Functioning Task Instructions

Adaptive Digit Ordering Task

You will now play the ORDER game. You will see a series of digits, one digit at a time. When instructed, you will type the number in ascending order. For example, if you saw 9-4-7, you will type 479. If digits occur twice, recall them twice. For example, if you saw 4-9-4, you will type 449. Press ENTER if you understand the game. If you do not understand, say ‘I do not understand’ out loud and we will assist you.

Forward Digit Span

You will now play the NUMBERS game. You will see a series of digits, one digit at a time. When instructed, you will type the number you saw. For example, if you saw 4-7-9, you will type 479. Press ENTER if you understand the game. If you do not understand, say “I do not understand” out loud and we will assist you.

Corsi Block Test

You will now play the SQUARES game. You will see an array of squares, which will light up one square at a time. When instructed, you will use the mouse to click on the squares in the order they lit up. Make sure to wait until a prompt appears on the bottom left of the screen instructing you to click. A counter displaying the amount of clicks you have left to make will also appear and change each time you click a square. Press ENTER if you understand the game. If you do not understand, say “I do not understand” out loud and we will assist you.

Stroop Task

You will now complete the COLORS game. You will see words in different colors. Please ignore what the word says and pay attention to the color of the word. Press the red key when you see a word that is Red, the green key when you see a word that is Green, the blue key when you see a word that is Blue, and the yellow key when you see a word that is Yellow. If you understand the game, press ENTER. If you do not understand, say “I do not understand” out loud and we will assist you.

Simon Effect

You will now complete the CIRCLES game. You will see a circle that is either Red or Green. Respond with the key that corresponds with the color of the circle as quickly as possible. Ignore where the circle appears on the screen. When you see (red circle), respond with the Red key on the keyboard (next to the caps lock key) with your left pointer finger. When you see a (green circle), respond with the green key on the number pad with your right pointer finger. If you understand the game, press ENTER. If you do not understand, say “I do not understand” out loud and we will assist you.

Verbal Fluency

You will now play the NAMING game. You will name different words that begin with a letter. Name as many different words as you can think of. For example, you may be given the letter “S.” You will then say examples like “soccer” or “slap” out loud. Do not name proper nouns like “Sarah” or “San Diego.” Also do not use the same word again with different endings, such as “slaps,” “slapping,” and “slapped.” The game will last 1 minute. If you understand the game, press ENTER. If you do not understand, say “I do not understand” out loud and we will assist you.

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