October 2022

The Role of Autobiographical Memory Recall in Reappraisal Efficacy and Effort Across Age

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A Thesis Presented

by

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Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE

September 2022

Psychological and Brain Sciences

Division of Clinical Psychology

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ABSTRACT

THE ROLE OF AUTOBIOGRAPHICAL MEMORY RECALL IN REAPPRAISAL EFFICACY AND EFFORT ACROSS AGE

SEPTEMBER 2022

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Socioemotional theories posit that the experience of overcoming unique life challenges over a lifetime enhances self-efficacy and emotional resilience among older adults. Older adults demonstrate greater emotional well-being and motivation to regulate emotions than younger adults, but specific regulatory mechanisms supporting late-life emotional resilience remain unclear. Cognitive reappraisal is an effective but cognitively demanding emotion regulation strategy and shows mixed efficacy in later-life. While a growing repertoire of autobiographical memories may be a resource with age, the role of autobiographical recall in momentary reappraisal has never been tested empirically. In this online study, older and younger adults were trained to reappraise the meaning of negative images as more positive by associating them either to any relevant autobiographical memory from the past (*n*=153), a specific cued autobiographical memory (reappraisal, *n*=118), or without autobiographical reference (*n*=156). Results revealed all strategies to be effective in regulating negative image intensity across age. While older adults outperformed younger adults in the non-AM condition, the opposite was observed for uncued AM reappraisals, and no age differences were found for cued AM reappraisals. Non-AM reappraisal was easiest to employ for all participants, and older adults reported all reappraisal

strategies as easier than younger adults. While older adults found their AMs more helpful and more similar to reappraised images than younger adults, AM- image similarity was surprisingly associated with lower reappraisal efficacy. Findings suggests that AM reappraisal benefits are mixed for older adults, likely due to efficacy but higher associated cognitive burden of AM recall. We posit that older adults may sacrifice immediate hedonic relief, to engage with challenging but helpful emotion regulation strategies. We discuss limitations of this study, and areas for future directions to substantiate interpretations further.

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CHAPTER 1

THE ROLE OF AUTOBIOGRAPHICAL MEMORY RECALL IN REAPPRAISAL EFFICACY AND EFFORT ACROSS AGE

1. Introduction

Emotion regulation is an adaptive process that promotes emotional well-being, playing a critical role in the maintenance of psychological health (DeSteno et al., 2013). Deficits in emotion regulation are implicated in psychopathology and associated with maintenance of mood disorders including major depression (Joormann & Stanton, 2016; Nolen-Hoeksema & Aldao, 2011) and generalized anxiety (Orgeta, 2011). Compared to younger and mid-life adults, prevalence of late-life mood disorders gradually decreases (Fiske et al., 2009). Older adults report greater emotional well-being (Mather, 2012), greater use of regulation strategies(Lawton, 2001), and older adults choose regulation strategies to benefit mood more flexibly(Blanchard-Fields, 2007). However, the specific cognitive mechanisms supporting successful emotion regulation processes in late-life remain unclear.

Cognitive emotion regulation strategies often help us to mitigate unpleasant feelings, such as reinterpreting a situation in order to decrease its negative impact (cognitive reappraisal (Gross, 2002). A large body of evidence suggests that reappraisal is both highly effective and successful at reducing emotional responsivity (Brockman et al., 2017; Denny & Ochsner, 2014; McRae et al., 2012). Reappraisal is also a critical component of cognitive behavioral therapy interventions (Clark, 2022) and effectively targets mood repair by instructing individuals to reframe negative emotions, subsequently attenuating negative mood (Troy et al., 2018). Successful reappraisal relies on cognitive control functions governing working memory,

inhibition, and updating (Ochsner and Gross, 2005; Ochsner et al., 2004). Given the gradual decline of these domains in healthy aging (Hedden & Gabrieli, 2004) it is not surprising that reappraisal is challenging to use effectively among older adults, (Braver & Barch, 2002; Kennedy & Raz, 2009; Opitz et al., 2012). However, cognitive reappraisal is often employed in isolation, without consideration of past life experiences.

Recalling details from one's life (i.e. remembering achievements, reminiscing on challenges overcome) positively influences cognition and mental health in both healthy and memory impaired older adults (el Haj et al., 2020; Speer & Delgado, 2017), as well as individuals with geriatric depression (Bohlmeijer et al., 2005).The collection of knowledge for one's unique life experiences, or *autobiographical memory (AM)*, contributes to a narrative of personal history, sense of self, and an evolving life story (Piolino et al., 2002). Remembering life events and key autobiographical facts is an age-invariant process (Martinelli et al., 2013). Thinking about one's past relies on a medial brain network (Spreng et al., 2009; Svoboda et al., 2006) that remains structurally and functionally intact well into late-life (Gutchess et al., 2007) and improves the accuracy with which both older and younger adults remember personal memories (Kalenzaga et al., 2015).

More critically, reappraising past life episodes of adversity is associated with greater present moment well-being (Morrill et al., 2008).Thinking about AMs related to life challenges facilitates problem-solving by making meaning of lessons learned, and integrating meaning-made into the global picture of one's life narrative (Park, 2010). Similarly, reflecting on growth from past crises predicts improved adjustment to new stressors (Park et al., 2005), and this process is facilitated across age. For instance, older adults identify narratives of resilience and recovery more often than younger adults when recalling adverse life events and include greater

themes of positive meaning and growth when discussing prior life crises (Pasupathi & Mansour, 2006; Singer et al., 2007). These findings highlight the adaptative and protective function of meaning made from life challenges and resilience memories. However, little research investigates the possible benefit of AM reflection in the context of *present-moment* emotion regulation. Memory for silver-linings achieved during past distress may be integrated into and facilitate reappraisal in the moment. AM recall may serve as a naturally occurring emotion regulation resource in older adulthood. Thus, the present study aimed to investigate the novel influence of autobiographical recall in momentary reappraisal in a lifespan sample, testing whether AM recall improved recovery and ease of momentary negative image reappraisal compared to a non-AM reappraisal strategy, as employed in previous studies.

1.1 Self-Reflection Improves Emotion Regulation, but AM Integration is Overlooked

Emotion regulation is founded on our motivation and attempt to influence our emotions (McRae & Gross, 2020) . While most studies of cognitive reappraisal manipulate instructions around engagement with, or avoidance of elicited emotion (McRae et al., 2012), limited studies consider the adaptive role of self-reflection in cognitive reframing. In past studies of emotion regulation, autobiographical reflection is used as a means of self-distancing from emotional stimuli via distraction. For instance, among young adults, autobiographical distraction to happy, but not neutral memories mitigated both physiological and emotional consequences of physiological stress induction (Speer & Delgado, 2017). Participants were instructed to reminisce about positive memories prompted by cues of common life events, but self-relevant features of AMs were not used to reappraise the physiological stressor, nor was this manipulated in a lifespan sample. While both AM distraction and non-AM reappraisal are equally effective regulation strategies for older adults, prior findings demonstrate that positive autobiographical

distraction is less effortful, whereas difference in reappraisal difficulty is not observed among younger adults (Martins et al, 2018). This study, however, failed to manipulate AM as an approach regulatory strategy, and only explored AM as a distraction strategy.

Prior neuroimaging accounts have explicitly compared self-relevant perspective taking across two types of reappraisal (self-relevant versus detached reappraisal) but similarly failed to extend findings to older adult age groups (Ochsner et al., 2004). Increasing self-relevance was used as a rumination strategy to exacerbate negative affect ("*You or a loved one could be involved"*), but AM in reduction of negative affect was not investigated. Our study adds novelty to a tome of reappraisal literature, expanding on the adaptive use of increased AM-reference in reappraisals of novel momentary stressors.

1.2 Past autobiographical experiences support emotion resilience with age

Socioemotional theories posit that motivation to make emotional meaning of life events increases with age (Carstensen et al., 2003). AM recollection serves multiple functions, including directive problem-solving (Bluck & Alea, 2002) from which life lessons from past experiences guide both present and future behaviors (Harris et al., 2014; Pillemer, 2003). Making meaning of AMs is an elaborative process, achieved by reflection on past successes and failures, laying important considerations for achievement of momentary and future goals (Conway et al., 2004; Park, 2010). Remembering the past to problem-solve links life-long experiences to an understanding of oneself (Bluck et al., 2005; Bluck & Habermas, 2000). Moreover, sharing narratives of lessons learned from past experiences contributes to a sense of self-efficacy when facing uncertainty(Glück & Bluck, 2007).

Meaning-making and positive narrative reframing are helpful in adjustment to long-term life events, unfolding over the course of months to years. For instance, in a longitudinal sample

of young to middle-aged adult cancer survivors, those individuals who reported a greater sense of personal growth from their cancer experience at 1-year follow up reported fewer intrusive thoughts related to their cancer diagnosis and greater overall well-being (Park et al., 2010). Other theoretical accounts post that reflection on past adversity helps survivors reappraise the negative features of their experiences to restore a sense of well-being and self-security in the present (Morrill et al., 2008). Unsurprisingly, those who are able to make meaning of their personal experiences of adversity demonstrate greater well-being and mental health in the long-run (Cox & McAdams, 2014; Lilgendahl & McAdams, 2011). Indeed, making meaning of how adverse life events may influence an individual's overall life story is associated with long-term resilience (Pals, 2006; Park, 2010), yet use of meaning-making is unexplored in the scope of reappraisal and momentary emotion regulation.

Reflecting on the meaning of AMs remains stable into late-life and is a developmental signature first emerging in young adulthood (Glück & Bluck, 2007). Unlike their younger counterparts, older adults report thinking about the past more often (Webster & Deng, 2015), and this may promote adaptive emotion regulation. For instance, older adults' memories of past experiences tend to contain more integrative meaning (i.e. what has the memory taught me about myself?) compared to younger adults (Singer et al., 2007). Older adults also value meaning-making for past events more, and engage in interpretation of past AMs more often in the context of personal growth, contributing to sense of well-being (Bauer et al., 2005). In a study of older adults who experienced highly stressful life-events (e.g. death of a loved one, personal disability and illness, combat experience) reports of greater sense for personal growth from traumatic experiences was associated with more adaptive coping during experience of new stressors (Park et al., 2005). When recounting AMs of life turning points and crises, older adults demonstrate a

greater reference to growth in one's identity as a result of their experiences, compared to their younger counterparts (Pasupathi & Mansour, 2006).

Despite the number of benefits conferred through AM reflection, particularly among older adults, increased self-relevance, narration of resilience, and meaning-making is often overlooked in emotion regulation paradigms. To date, one study empirically manipulated AM recall of critical self-defining memories, and their subsequent influence on reappraisal use. Recalling a critical AM of overcoming a challenging event, above merely recalling a past positive autobiographical memory, was associated with enhanced subsequent reappraisal of a prior negative AM (Paersch et al., 2021). However, this study investigated the global impact of recalling resilience memories, and only among younger adults. Direct linking of AMs recalled to the present reappraisal was not explored. Prior studies pave convincing evidence that successful coping efforts from the past may promote resolution of momentary distress by analyzing effective strategies and re-accessing them when needed (Meléndez et al., 2015). Existing studies, however, neglect the potentially buffering role of meaning-making and AM reflection in the context of momentary emotion regulation.

1.3 AM integration relies on cognitive processes and medial brain regions preserved with age

AM retrieval activates midline brain regions of the prefrontal cortex (Cabeza & St Jacques, 2007), which structurally maintain integrity in late-life and are posited to support social, affective, and cognitive functions (Gutchess et al., 2007). The engagement of these regions is most critical to the context of AM reflection and problem-solving. Activation of the medial prefrontal cortex is implicated in the interaction of newly learned information and prior knowledge (Schlichting & Preston, 2015). Reminders of related memories prior to engaging in a new experience bolsters integration, reactivating and updating past experiences (Hupbach et al.,

2011). Moreover, memory integration is thought to be biased towards behaviorally relevant memories, through medial prefrontal activation (van Kesteren et al., 2012). Preserved medial networks may, therefore, support reactivation of past relevant memories for momentary use. Indeed, memory representations in the medial prefrontal cortex support retrieval of related memories during new events (St Jacques, Olm, and Schacter, 2013), drawing on past pertinent memories to inform behaviorally appropriate responses in the moment (Kroes and Fernandez, 2012).

Interestingly, distinct neural pathways are implicated in supporting different instructional variants of reappraisal (Ochsner, 2004), suggesting that the demands on reappraisal depends on regulatory goals and demand characteristics. These findings highlight that not all forms of reappraisal rely on age-dependent cognitive functions. Cognitive control governs broader executive functions such as working memory and attention, and these processes are ostensibly crucial to successful reappraisal (Owen et al., 2005), but self-reference in emotion regulation may be well-supported with age in contrast to cognitive control. That is, stable midline regions may better support construction of self-focused reappraisals during emotion regulation in older adulthood.

1.4 Cueing facilitates AM retrieval, and reduces cognitive burden of AM search

AM recall is comprised of two processes, starting with a *search* for and retrieval of a relevant AM, and subsequent *elaboration* upon the specific details of the AM retrieved (Holland, Addis and Kensinger, 2011). In a laboratory setting, memory construction is an iterative process (Addis et al., 2012) in which one searches for and retrieves a task-appropriate AM and search is terminated when task contextual demands are met. The hierarchical model of autobiographical memory retrieval (Conway & Pleydell-Pearce, 2000) outlines high cognitive load associated with

reconstructing specific details of AMs. Recent revisions of this model suggest that cues with high emotional salience elicit greater retrieval of memory details (Sheldon et al., 2020). Moreover, cues support faster access to key AMs and older adults selectively recall more detailed AMs when self-relevant descriptions of AM contexts (ie. life-period) are narrated, prior to recall of the cued AM (Dijkstra & Kaup, 2005).

Compared to younger adults, older adult search for self-relevant memories is truncated to early hierarchical stages, ending AM search earlier than younger adults and retrieving memory details that are more abstract and less detailed (Wank et al., 2021). Older adults also retrieve fewer autobiographical memory details (Grilli et al., 2018), and demonstrate reduced retrieval of memory-specific autobiographical details during problem-solving of common social conflicts ("Your friend is angry with you"; Peters et al., 2019). Consistent with Conway and Pleydell's hierarchical model of AM retrieval, burden to cognitive load may limit AM reconstruction. Thus, an unconstrained memory search to AM retrieval may be cognitively costly for older adults compared to task demands that emphasize AM context aided by a cue.

Contending evidence suggests that specificity of AM recall remains stable and is age-equivalent when older adults retrieve key life memories that contribute to their sense of self (Cuervo-Lombard et al., 2021; Martinelli et al., 2013). For instance, when cues are personally relevant and capture gist information (e.g., retrieving an AM associated with the cue "my little sister's 18th birthday") a memory may be directly accessed and thus more quickly retrieved (Uzer & Brown, 2017) in a manner that is less cognitively demanding than recalling AMs to generic cues (i.e., "birthday"). Functional imaging approaches suggest that generic versus specific AM cues lead to critical neural differences. While generic cues activate memory regions vulnerable to aging during AM construction, salient, self-relevant cues activate regions of the medial AM

network which are less subject to age-related decline (Addis et al., 2012; Cabeza & St Jacques, 2007) and critical to self-reflection (Gutchess et al., 2007; Wagner et al., 2012). Stronger activation across medial AM networks during specific, cued AM recall is associated with faster AM construction and more personally significant AMs (Addis et al., 2012). Therefore, cue-aided retrieval of AMs may reinforce cognitive processes subject to age-related decline, and we designed our task to manipulate cued and uncued use of AM recall, to account for the cognitive burden induced by AM memory search processes.

1.5 Integrating Autobiographical Memories in Reappraisal: A Novel Approach

AM recall for resilience memories remains an unexplored component of reappraisal in late-life and may rely upon neural pathways and AM retrieval processes intact across age. Given the greater use of self-knowledge in problem-solving with increasing age (Piolino et al., 2002; st. Jacques & Levine, 2007), manipulating AM in reappraisal of negative images was a key gap in the current literature that our study aimed to clarify.

In this study, we designed a novel emotional regulation paradigm in which reappraisal was employed in association with recall of an uncued resilience AM or specific resilience AM, and compared to a control reappraisal strategy, attending to the situational features of a negative scene only, without AM reference. We aimed to track differences across AM and non-AM conditions, while controlling for the cognitive demands involved in AM search across the cued and uncued conditions. Dependent variables included reappraisal efficacy via changes in emotional intensity ratings pre- and post-strategy use, as well as self-reported difficulty of employing each strategy.

We hypothesized that recall of self-defining AMs would facilitate reappraisal efficacy to a greater degree and reduce difficulty to reappraise, in comparison to non-AM approaches. Gold

standard reappraisal strategies that focus on modifying situational facets of emotion eliciting stimuli, without considering past life experiences are cognitively taxing to employ for older adults (Martins et al., 2018; Opitz et al., 2012)despite the importance of controlling instructional specificity and reappraisal goals being well established in past reports (McRae et al., 2012; McRae & Gross, 2020).

Given the key role of cueing on AM retrieval difficulty and cognitive control (Addis et al., 2012; Dijkstra & Kaup, 2005; Uzer & Brown, 2017)we designed a task that includes two conditions- an unconstrained approach allowing for free memory search, and a cued approach, which may grant access to a larger repertoire of life memories. We outline two possible hypotheses that could arise from these two conditions. We proposed that use of an uncued AM integration approach might more effectively lower emotional intensity due to the greater relevance of the AM in relation to the to-be-reappraised stimulus, given that successful coping efforts from the past may readily promote resolution of momentary distress via memory retrieval (Melendez et al., 2015). That is, we may expect that a contextually relevant memory would promote greater meaning-making potential. However, given the added cognitive load associated with early stages of memory search (Conway & Pleydell-Pearce, 2000), we hypothesized that uncued AM integration may be more difficult for older adults than younger adults.

In contrast, it may be the case that provision of specific autobiographical cues reduce cognitive burden. Given that AM recall is age equivalent for self-defining AMs (Dijkstra & Kaup, 2005; Sheldon et al., 2020), a cued approach could reduce the cognitive load associated with memory search, and instead, open greater cognitive resources to be utilized for meaning-making and integration of reappraisals with past memories. Thus, we may expect age-equivalent

efficacy for a reappraisal using a cue-supported AM, and greater efficacy for cued AM than uncued in later-life.

We also tracked subjective measures of memory similarity to the image to be reappraised, as well as perceived helpfulness of the memory to reappraisal use, to aid in interpretation of our findings. Prior work supports that neural memory representations become more similar with repeated retrieval over time, with advancing age (St-Laurent et al., 2014) and lifespan neural dedifferentiation may support integration of memories that share overlapping associations (Martins-Klein et al., 2022; Preston & Eichenbaum, 2013). Therefore, we hypothesized that greater memory to image similarity would support reappraisal efficacy in AM reappraisal. Given that older adults have a greater repertoire of accumulated life experiences to pull from (Rubin, 2005), we predicted that older adults may find more shared overlap in similarity among their AMs and novel stressors. Similarly, we expect that older adults may find their AMs more helpful during reappraisal, as older adults enhance emotional resilience via more frequent recall and integration of positive narratives following adverse life events compared to younger adults (Bauer et al., 2005; Pasupathi & Mansour, 2006; Singer et al., 2007).

2. Method

2.1 Participants

Participants provided separate assent for screening and study participation as approved by the University of Massachusetts Institutional Review Board (IRB). Participants were paid for participating in the screening measure ($0.60 USD) and emotion regulation task separately ($7 USD).

Six hundred and two younger adults (age 18-29, M_{age} *25.16*, *SD* = 3.74, 65% Female) and 564 older adults (age 60-84, M_{age} = 64.12, *SD* = 7.27, 55% Female) were recruited using

CloudResearch (Litman & Robinson, 2020) to participate in the study screening form. Participants were screened for age (18-29 for younger adults, 60-85 for older adults), US residency, English fluency, greater than a 95% Mturk approval rating to decrease financially incentivized study completion (Mitra et al., 2015), and congruent reports of age (n=130 excluded, e.g., "what year were your born?" versus "how old are you?"). Task engagement was evaluated via the Winograd Attentional Check questionnaire (Levesque et al., 2012.; See Appendix A for sample questions) and Instructional Manipulation Check (IMC; Oppenheimer et al., 2009), which screens for attention and basic reading comprehension (*n*= 135 excluded). Attention and effort checking tasks discriminate human from bot submissions and demonstrate sensitivity at discriminating among participants exercising low task engagement (Allahbakhsh et al., 2013).

A total of 901 participants who met these screening criteria were invited to participate in the main study (Figure 1). Participants who provided assent to participate but failed to complete at least 60% of the task were excluded (n=169 excluded). Participants whose average values for the two study dependent variables (detailed below) fell within 3 standard deviations of the mean were also excluded (n=2). Thus, the final study sample included 219 younger adults (age 18-29, M_{age} = 25.07, *SD* = 2.61, 56% Female) and 208 older adults (age 60-84, M_{age} = 65.63, *SD* = 4.45, 69% Female) (see Table 1A for demographic breakdown).

2.2 Qualitative Reappraisal Condition Manipulation Checks and Procedures

Trial-level reappraisal transcripts were coded for strategy adherence by a team of 3 undergraduate research assistants supervised by the study PI. Participant responses were binarily scored. Responses were deemed accurate when participants successfully associated their experience to the image outcome and/or referenced a life memory of resilience (uncued AM

condition) or the memory associated with their cue (cued AM condition) during reappraisal. A plausible silver-lining or reframing of the stimulus meaning was coded as accurate for the non-AM control condition (see table 1B for break-down of number of trials missed by condition and age). Interrater reliability was high with concordance above 90% across trials. Consensus was made to break ties on discrepant trials via coding by the study PI. Analyses reported here were run only on trials deemed accurate based on the manipulation check criteria, and for those participants that completed at least two-thirds of trials accurately.

2.3 Session Timeline

Eligible participants were invited to complete a one-hour online session on an internet-based platform, Amazon's Mechanical Turk (MTurk, Crowston, 2012; see Figure 1 for study timeline). Participants who provided study assent completed an AM Generation Task, Reappraisal training, Emotion Regulation Task, and post-task measures and questionnaires. All participants were debriefed about the study aims and paid at the end of the session. Task timing parameters, number of trials, and individual measures were adapted via piloting, to ensure approximately 60 minutes for task completion. The session had a median completion time of 53.2 minutes across all conditions.

2.3.1 AM Generation Task

Participants completed a modified version of the Self Defining Memory Task (SDT; Singer and Blagov, 2001). Participants were asked to recall 3 unique AMs of an experience of adversity in their personal life that was highly self- relevant (Blagov and Singer, 2004), with specific focus on resilience memories in which participants overcame a challenge and/or learned a lesson. For each AM, participants typed detailed narratives describing the relevance and impact of the AM on their life, focusing on the growth or lesson learned from the memory. Participants

then rated strength of affect evoked by recalling the memory (eg. Happy, sad, angry) on a scale of 0 (not at all) to 6 (extremely), memory vividness and importance (0-6 scale), and temporal proximity of the memory in years (Blagov and Singer, 2004).

2.3.2 Reappraisal Training

Participants were randomly assigned between-subjects to a reappraisal condition: *non-AM, cued AM* or *uncued AM*. Participants were instructed to reappraise a slideshow of negative images and asked consider them real, and not think of images as fake or staged (e.g., "it's just a movie"). Across all conditions, participants were asked to reappraise images by considering how the situation in the image may turn out ok in the end (non-AM control condition). Participants in the uncued AM condition were instructed to reappraise the image by considering *any meaningful AM from their lives that applies to the situation*, so that the specific memory helps make the situation depicted in the image feel more positive. In contrast, individuals in the cued AM condition were prompted with the 1-3 word cue from the AM generation task and asked to consider how that specific memory relates to the situation depicted in the image so that it feels more positive (see Appendix B for full condition instructions).

Participants were trained on three negative training images that were not seen again in the task. The assigned strategy was trained via two demonstrations images, in which the strategy, and subsequent use of strategy was described in full detail. Instructions were provided with example responses, and participants were then prompted to provide their own reappraisals in writing. Each demonstration was followed by a "corrective" feedback slide, where an example of alternative acceptable responses was provided. A follow-up demonstration trial was modeled start to finish, during which each step of the trial timeline was described in detail, including ratings. At the end of task training, all participants were provided with instructional reminders

and asked to define, in their own words, the goal of "view", "prepare", and "rethink" instructions as a manipulation check of task encoding.

2.3.3 Stimuli

Nine negative image stimuli were selected from Nencki Affective Picture System database (NAPS, (Marchewka et al., 2014). Images included ambiguous contexts involving human/person situations (i.e. medical procedures, car accident, pain, poverty). Images for the emotion regulation task were selected for negative valence (M_{val} = 2.73, SD= 1.15) on a scale from 1(very negative) to 9 (very positive), and moderate arousal (M_{aro} = 4.48, SD= 2.01) on a scale from 1(relaxed) to 9(aroused) based on published ratings (Riegel et al., 2015)

2.3.4 Emotion Regulation Task Timeline

Participants viewed the negative image slideshow in randomized order. All trial slides were self-paced and separated by a 3s intertrial fixation. Images were organized into three blocks of three trials, followed by a self-paced break (see Figure 2 for task timing details). At the start of each trial, participants were asked to "view" the negative image and rate baseline image intensity on a scale of 1 (not at all intense) to 9 (extremely intense).

Participants were then shown a condition-specific cue to prepare reappraisal. For the cued AM condition, participants were presented with a 1-3 word cue generated in the initial AM Generation Task, denoting the specific AM with which the image should be reappraised. Of note, cued AM participants were cued to recall the same memory for each block of three image trials, with memory order randomized across blocks. In contrast, uncued AM participants were presented with a "Prepare AM" cue to recall *any* relevant past AM that was helpful to their reappraisal of the image. Participants in the non-AM condition were presented with a "Prepare" cue and were told to get ready to reappraise during that time without any AM reference. After the

preparation cue, participants reappraised the negative image and qualitatively described in writing how they carried out their reappraisal. At the end of each trial, all participants rated image intensity on the same scale of 1(not at all intense) to 9 (extremely intense), and how difficult it was to reappraise the image with their instructed strategy on a scale 1(not at all difficult) to 9 (extremely difficult). In both AM conditions, at the end of the trial participants also rated the similarity of their AM to the image on a scale of 1(not at all similar) to 9 (very similar), and how helpful their AM was in reappraising the image on a scale from 1(not at all helpful) to 9 (very helpful).

2.4 Self-reported Measures

2.4.1 Affective and Functional Health

Functional and emotional health were assessed using the Patient-Reported Outcomes Measurement Information System 29-Item Profile Measure (PROMIS-29- Version 2; (Cella et al., 2010). The PROMIS-29 tracks 7 domains of functioning (*anxiety, depression, fatigue, pain, captured by pain interference and intensity, sleep disturbance, physical functioning and ability to participate in social roles*), and each domain comprises four items with five-point descriptive scales, except for pain intensity which has a 0–10 rating scale. The sum of the item responses for each multi-item domain were converted to T-scores where a score of 50 represents the average for the US general population with a standard deviation of 10 (Rothrock et al., 2020). Higher scores represent more of a domain, such that for the domain of physical function, higher scores represent better health whereas for anxiety, higher scores represent poorer health. The PROMIS-29 demonstrates good estimated reliability for physical (0.93-0.95) and mental health (0.97 – 0.98). Internal consistency is adequate across all domains ($\alpha > 0.90$), with exception of sleep-disturbance ($\alpha = 0.77 – 0.88$) (Cella et al., 2010; Hays et al., 2018).

2.4.2 Baseline and Post-trial Mood

Participants completed the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) at baseline and post-task as an assessment of mood. The PANAS is a 20-item self-report scale that measures subscales of positive affect and negative affect using two 10-item mood scales. Participants are instructed to rate the extent to which they feel a certain emotion "at this moment" on a scale from 1 (very slightly or not at all) to 5 (very much). The PA and NA scales are quasi-independent (rs = -.05 to -.35). Internal consistency is adequate for the PA (α = .89) and NA scales (α = .85) (Crawford and Henry, 2004), and has been validated for use among older adults (Humboldt et al., 2017).

2.5 Study Dependent Variables

We tracked two dependent variables in the study: reappraisal *efficacy* and *difficulty*. For each participant trial, strategy efficacy was operationalized as a change intensity score (Δ intensity), which was calculated by subtracting post-reappraisal image intensity rating from the baseline image intensity rating. A subject-level mean Δ intensity score was calculated across all trials for each participant. Similarly, a subject-level mean difficulty score was averaged across trials for the post-reappraisal difficulty rating.

2.6 Data Analysis

All analyses were conducted in SPSS (Version 25.0, IBM SPSS Statistics, Switzerland) with significance level $p < 0.05$. Preliminary analyses examined age group differences in sociodemographic and functional/mental health variables using univariate ANOVA or χ^2 tests (see table 1A and 1B). A series of mixed ANOVAs were conducted to determine the fixed effects of age (younger, older) and reappraisal condition (non-AM, uncued AM, and cued AM) on strategy efficacy (Δ intensity) and difficulty to reappraise. Tukey HSD -adjusted post-hoc t-

tests clarified interaction effects. Simple bivariate correlations and linear regressions examined the relationship between secondary variables of interest (memory to image similarity and helpfulness of memory) and dependent outcome variables.

Analyses were also conducted using Mixed Linear Modeling (MLM) in MPLUS (Muthen and Muthen, 2017) to account for trial-level variability, with fixed effects of age (Younger Adults, Older Adults) and Condition (Non-AM, Uncued AM, Cued AM) and crossed random effects of subject and trial for dependent variables of efficacy and difficulty to reappraise. MLM results reflected the same findings as ANOVA models, and thus ANOVA results are reported below as the most parsimonious analysis approach.

3. Results

3.1 Demographic and Stimulus Differences across Age

Demographic analyses revealed that the study sample was predominantly female (62.3% female, $\chi^2 = 5.883$, $p = 0.015$), which is consistent with the demographic base of MTurk worker samples (Huff & Tingley, 2015). Older adults in our sample had greater years of education ($M_{older} = 15.31$, $SD_{older} = 2.46$) relative to younger adults, ($M_{younger} = 14.73$, $SD_{younger} = 2.07$), $t(425) = 2.43$, $p=0.016$, and younger adults were significantly more stressed than older adults, $t(425) = -6.422$, $p<0.001$). At baseline, older adults ($M = 6.78$, $SD = 1.12$) rated images as more emotionally intense than younger adults ($M = 6.05$, $SD = 1.37$), $F(1,411) = 32.515$, $p<0.001$, $\eta_p^2 = 0.073$, *but no* significant differences were found across condition ($p = 0.772$), nor across the interaction of age x condition ($p = 0.243$). To ensure that age effects were not entirely explained by these potential confounding observed differences in education, gender, and baseline image intensity, all models were run with these factors as covariates.

3.2 Functional Health Variability Across Age

Age differences were observed across all 7 domains of the PROMIS-29. Younger adults reported greater depression, (p <0.001), anxiety, (p <0.001), sleep disturbance (p <0.001) and fatigue (p <0.001), and greater integrity of physical function (p <0.001) compared to older adults (see Table 2). In contrast older adults reported more pain (p = 0.002), and less engagement in fulfilling activities (p = 0.025), than younger adults. Relative to PROMIS-normed clinical cut-offs, neither age group reached clinical levels of anxiety or depressive symptomology however, engagement in activity was lower for both age groups in our sample relative to PROMIS-29 US-population norms (Hays et al., 2018)which may be associated with COVID-19 pandemic era restrictions. Younger adults randomized into the non-AM condition reported less fatigue (p = 0.002), than those randomized into the uncued and cued AM conditions. No other differences in PROMIS-29 outcomes were observed across conditions. When participant fatigue was modeled as a covariate in analyses, the effect of fatigue did not alter study outcomes.

3.3 Data Quality and Manipulation Checks

3.3.1 Trial Variability

We ran exploratory analyses of order effects across trials within blocks, and across-blocs. Two 2x3x3 mixed ANOVAs were run with between factors of age (younger, older) x condition (non-AM, uncued AM, cued AM), and within-subject effect of time (Block 1-3) on the dependent variables of change in image intensity, and reappraisal difficulty in separate models. Two additional models were run with the same ANOVA structure, but with time as a predictor defined as trials 1-3 within a block. Covariates of gender, education, and baseline image intensity were included in all models run.

For efficacy ratings, an effect of time was observed $F(2, 818) = 4.039$, $p = 0.018$, $\eta_p^2 = 0.010$, such that change in image intensity diminished by the third trial ($M = 0.49$, $SD = 1.14$), across all blocks, relative to trials 1 ($M = 0.67$, $SD = 1.12$) and 2 ($M = 0.67$, $SD = 1.05$), however, variable change in intensity was not observed across blocks 1-3 ($p > 0.05$). No other effects were significant.

For difficulty ratings, neither order effects of age, condition, timing, nor the interaction of these factors were significant when comparing within trials 1-3 ($p > 0.05$). However, across the 3 blocks, there was a trending interaction effect of Time x Condition, $F(4, 832) = 2.373$, $p = 0.051$, $\eta_p^2 = 0.011$. Across blocks 1 and 2, difficulty was significantly different across all 3 conditions, such that reappraising with a cued AM was most difficult ($M = 5.55$, $SD = 12.04$), followed by uncued AM reappraisal ($M = 4.46$, $SD = 1.99$), and non-AM reappraisal ($M = 3.69$, $SD = 1.77$). However, by the third block, differences in difficulty to reappraise between the uncued AM and non-AM condition diminished ($p = 0.116$), while the cued-AM strategy remained most difficult to utilize ($p < 0.001$).

3.3.2 Differences in baseline affect and change in affect over time

Two univariate ANOVAs were conducted on baseline positive affect and negative affect scores, respectively, with age and condition as fixed factors, covarying for gender and education. Neither main effects of age, condition, nor interaction of age x condition were significant for positive nor negative baseline mood scores (both p's > 0.10). We also examined if participants' positive and negative affect was affected by the experiment, by conducting two 2x3x2 age (younger, older) x condition (non-AM, uncued AM, cued AM) x time (baseline, post-task) mixed ANOVAs for positive and negative affect. There were no main effects of age, condition, time, or interaction of these factors for positive affect. However, an interaction of time x age was

observed for negative affect, $F(1, 410) = 6.620$, $p = 0.010$, $\eta_p^2 = 0.016$. While older ($M = 13.02$, $SE = 0.32$) and younger adults ($M = 13.32$, $SE = 0.31$) reported the same degree of negative affect at baseline, $t(416) = -0.990$, $p = 0.323$, and both age groups reported greater negative affect after the task, this effect was greater in magnitude among younger ($\Delta_{NegativeAffect} = 2.072$), relative to older adults ($\Delta_{NegativeAffect} = 1.05$, $t(405.550) = -2.462$, $p = 0.014$. Including baseline negative affect, negative affect after task completion, or change in negative affect as covariates did not alter primary findings (Table 1B).

3.4 Emotion Regulation Task Results

3.4.1 Non-AM reappraisals are most effective for older adults, but all strategies are equally effective for younger adults

A 2x3 univariate ANOVA was run to examine the effects of age (younger, older) x condition (non-AM, uncued AM, cued AM) on Δ image intensity, covarying for effects of education, gender, and baseline image intensity. Results revealed a significant main effect of condition, $F(2,410) = 9.783$, $p<0.001$, $\eta_p^2 = 0.059$. Post-hoc t-tests revealed that for both age groups, non-AM reappraisal was more effective at reducing intensity, relative to uncued AM, $t(301.85) = 5.087$, $p<0.001$ and cued AM conditions, $t(272) = 3.24$, $p=0.001$. There was also a significant interaction of age x condition $F(2,410) = 6.032$, $p=0.003$, $\eta_p^2 = 0.029$, and post-hoc t-tests were run to clarify the interaction effect. For younger adults, strategy efficacy was not significantly different across conditions ($p = 0.471$). In contrast, older adults drove the interaction via a stepwise effect in which non-AM strategy was most effective ($M_{\Delta\ intensity} = 1.16$, $SD = 1.12$), followed by cued AM strategy ($M_{\Delta\ intensity} = 0.57$, $SD = 0.88$, $t(154.02) = 5.33$, $p <0.001$). The uncued AM strategy was least effective ($M_{\Delta\ intensity} = 0.31$, $SD = 0.89$, $t(119.64) = 3.385$, $p = 0.001$; Figure 3) . No significant main effect of age was found *($p = 0.465$)*.

After removing the non-AM strategy from omnibus analyses, the interaction effect was no longer significant, $F(1,257) = 1.311$, $p = 0.253$, $\eta_p^2 = 0.005$, suggesting that the differences observed in efficacy were primarily driven by non-AM strategy, relative to AM strategy outcomes among older adults. However, further exploratory analyses did reveal a trending effect of condition in which the cued AM strategy was marginally more effective at reducing image intensity relative to the uncued AM reappraisal among older adults only, $F(1,120) = 3.063$, $p = 0.083$, $\eta_p^2 = 0.025$. No such difference was found for younger adults, $F(1,134) = 0.068$, $p = 0.794$, $\eta_p^2 = 0.001$ (Figure 3).

Independent sample t-tests were conducted within each condition to test effects of age, covarying for education, gender, and baseline image intensity. Main effects of age were detected for the non-AM condition, $F(1,150) = 7.587$, $p = 0.007$, $\eta_p^2 = 0.058$, such that efficacy was greater for older ($M_{\Delta\ intensity} = 1.16$, SD = 1.12) relative to younger adults ($M_{\Delta\ intensity} = 0.62$, SD = 0.63). Interestingly, a main effect of age in the uncued condition revealed a trending effect $F(1,142) = 3.063$, $p = 0.081$, $\eta_p^2 = 0.021$, where young adults showed greater benefit from using the strategy ($M_{\Delta\ intensity} = 0.47$, SD = 0.78) compared to older adults ($M_{\Delta\ intensity} = 0.31$ SD = 0.89). No difference across age was found for change in intensity score for the cued condition.

3.4.2 Reappraisal is more difficult for younger adults and AM-reappraisals are globally more challenging to use

A 2x3 univariate ANOVA was run to determine the effects of age (younger, older) x condition (non-AM, uncued AM, cued AM) on reappraisal difficulty. Covariates of education, gender, and baseline image intensity were included in the model. Results revealed a significant main effect of age $F(1, 410) = 8.498$, $p = 0.004$, $\eta_p^2 = 0.020$, in which younger adults ($M = 4.87$, $SD = 1.85$) found reappraisal more difficult than older adults across all conditions ($M = 4.26$, $p =$

1.82*), t(*425*)* = -3.416, *p*<0.001. A main effect of *c*ondition on reappraisal difficulty was also detected, $F(2,410) = 29.23$, $p<0.001$, $\eta_p^2 = 0.125$. *A* step-wise effect was observed for both age groups, such that non-AM reappraisal was rated least difficult to implement $M_{Difficulty} = 3.85$, $p = 1.61$, followed by uncued AM reappraisal $M_{Difficulty} = 4.53$, $p = 1.80$. Cued AM use was rated as the most difficult strategy to employ, $M_{Difficulty} = 5.58$, $p = 1.86$*;* Figure 4. An interaction effect was not observed ($p = 0.753$).

3.4.3 Older adults find AM recall more helpful to reappraisal than younger adults.

A 2x2 univariate ANOVA was conducted to examine the effects of age (younger, older) x condition (uncued AM, cued AM) on perceived helpfulness of AM recall to reappraisal, covarying for effects of education, gender, and baseline image intensity. Results revealed a significant main effect of age $F(1,257) = 6.617$, $p=0.011$, $\eta_p^2 = 0.025$, in which older adults found both AM strategies (cued and uncued) more helpful ($M_{Helpfulness} = 6.23$, SE=0.1) than younger adults ($M_{Helpfulness} = 5.48$, $SE=0.12$), $t(268.98) = 4.499$, $p<0.001$ (Figure 5). A main effect of condition was also observed $F(1,257) = 21.573$, $p<0.001$, $\eta_p^2 = 0.077$, in which uncued AM reappraisal was rated as more helpful ($M_{Helpfulness} = 6.20$, $SE=0.12$) than cued AM reappraisal ($M_{Helpfulness} = 5.50$, $SE=0.14$), $t(220.37) = 4.029$, $p<0.001$. An interaction effect was not observed ($p = 0.734$)

3.4.4 Uncued AMs are more similar to novel stressors than cued AMs during reappraisal

A 2x2 univariate ANOVA was conducted to examine the effects of age (younger, older) x condition (uncued AM, cued AM) on self-reported similarity between the recalled AM and negative image stimulus, covarying for education, gender, and baseline image intensity. First, a main effect of age was detected $F(1,257) = 4.326$, $p=0.038$, $\eta_p^2 = 0.017$. Older adults rated their

memories as more similar across both AM conditions *($M_{Similar}$ = 5.16, SD = 1.68)* than younger adults *($M_{Similar}$ = 4.25, SD = 1.92)*. A main effect of condition was also observed, $F(1,257)$ = 120.25, $p<0.001$, $\eta_p^2 = 0.319$), in which uncued AMs were rated as more similar to the reappraised images *($M_{Similar}$ = 5.55, SE = 0.12)*, than cued AMs *($M_{Similar}$ = 3.60, SE = 0.13)*, which were assigned memories from the AM generation task and not tailored to each trial. Additional independent samples t-tests examining the effect of age (younger, older) on AM-image similarity were conducted within each AM reappraisal condition. While the cued condition revealed no difference in similarity ratings across age groups *(p = 0.126)*, the effect of similarity rating in the uncued condition by age was significant, $t(151) = 3.965$, $p < 0.001$, such that older adults rated their memories as more similar to the stimulus *($M_{Similar}$ = 5.97, SD = 1.23)* relative to younger adults *($M_{Similar}$ = 5.05, SD = 1.63; Figure 6)*.

3.4.5 AM-image similarity is associated with reduced reappraisal efficacy and difficulty.

Exploratory analyses revealed that across AM conditions, AM-image similarity shared a negative relationship with strategy efficacy, such that greater AM similarity to the image reappraised was associated with lower efficacy of AM strategies *(r =- 0.120; β = -0.055, p = 0.049, r^2 = 0.014)* and this effect was driven by older, *(β = -0.085, p = 0.072, r^2 = 0.026)* relative to younger adults, *(β = -0.032, p = 0.366, r^2 = 0.006; Figure 7)*. In contrast, as expected, greater reported image-memory similarity *(r= - 0.444, $p<0.001$)* and helpfulness of memory to reappraise *(r= - 0.339, $p<0.001$)* were both associated with lower self-reported reappraisal difficulty (Figure 8). Memory to image similarity and perceived helpfulness of memory were highly collinear, r = 0.620, p <0.001, thus similarity and helpfulness were modeled independently as predictors in follow-up linear regressions. Both similarity, $\beta_{similarity}$= -0.394,

$p<0.001$, $r^2 = 0.201$, and helpfulness, $\beta_{Helpfulness} = -0.412$, $p<0.001$, $r^2 = 0.115$, predicted the difficulty with which participants used AM strategies.

4. Discussion

Life experience is suggested to promote wisdom and emotion regulation fluency across the lifespan (Martins-Klein et al., 2022)yet empirical support for the role of autobiographical memories in reappraisal processes is limited. This study examined the influence of life memories of resilience on momentary reappraisal through use of a novel emotion regulation paradigm. We compared non-AM reappraisal to a novel autobiographical strategy where AMs of self-efficacy, and/or lessons learned from past life challenges were associated with negative images in order to better reappraise them. Our study addresses a critical gap, exploring the utility of life experience in emotion regulation. Findings extend the existing literature by demonstrating both benefits and limitations to using AM integration in momentary reappraisal across age.

Our results highlight that all reappraisal strategies, including AM reappraisal approaches, significantly reduced reported intensity of emotion for participants of all ages. In fact, younger adults demonstrated no difference in change of intensity across AM and non-AM reappraisal approaches, suggesting these strategies are equivalent in efficacy. Thus, our findings provide initial support for autobiographical reappraisal as an effective approach strategy that increases self-relevance, in order to improve affect towards negative emotional stressors. We add to past work with reappraisal strategies that involve reducing the self-relevance (Ochsner et al., 2004) or engaging in self-referential distraction to improve affect towards negative emotional images (Martins et al., 2018). This dovetails with recent findings that recalling past AMs of successful coping lowers momentary distress and negative affect and increases stress tolerance among refugees, asylum seekers and survivors of torture (Morina et al., 2018). We provide added

support to theoretical accounts that recalling life memories of resilience and accomplishment may aid the process of contextualizing or "putting into perspective" other negative life experiences, promoting emotion regulation and positive mood ((Conway et al., 2004). Recent research also suggests that among young adults, recalling episodes of self-efficacy – events where a difficult situation was managed successfully – enhanced subsequent reappraisal of past negative autobiographical events, above and beyond recalling unrelated positive memories prior to reappraisal attempts (Paersch et al., 2021). Our study expands on these findings, suggesting that not only unrelated AM resilience recall aids reappraisal, but that *associating* the lessons learned from these events directly to momentary reappraisal of acute stressors is beneficial. In addition, our findings extend prior work by demonstrating that AM reappraisal is effective for not only younger, but also older adults as supported by our lifespan results.

Interestingly, older adults outperformed younger adults in non-AM reappraisal use. This age difference replicates two past studies, which found situational (non-AM) reappraisal efficacy to improve with age, specifically for instructions that highlight increased positive engagement with reappraised stimuli (Lohani & Isaacowitz, 2014; Shiota & Levenson, 2009). It is worth noting that past studies of non-AM reappraisal are mixed, suggesting that older adults may benefit more from strategies such as distraction (Smoski, 2014; Tucker 2012), while other studies find no age differences (Martins et al., 2018; Winecoff et al., 2011)or greater reappraisal efficacy for younger than older adults (Opitz et al., 2012).

In regard to metrics of difficulty, older adults broadly found reappraising less difficult and more helpful than their younger peers, and this effect was consistent across AM conditions that are theoretically more cognitively taxing. Reduction of emotional intensity is only one metric of emotion regulation efficacy, and other regulatory motives may promote "effectiveness"

even in the face of lower immediate hedonic benefits. Seminal research demonstrates priority for positive, low intensity emotion among older adults (Carstensen et al., 2003). While time left to live (Socioemotional Selectivity Theory, Carstensen et al., 2003) and experiential self-knowledge promotes priority for well-being, late-life is also met with vulnerabilities including the avoidance of negative situations and greater difficulty mitigating emotional responsivity to emotionally arousing situations. On the contrary, we add nuance to well-established models of lifespan socioemotional well-being such that older adult may find greater self-relevance in reappraisal less effective, but also less difficult and more helpful than their younger counterparts.

Adaptive emotion regulation strategies vary in their efficacy in alignment with momentary versus long-term goals. For example, distraction – an adaptive momentary strategy-focuses on immediate hedonic motivations to reduce negative and enhance positive affect (Scheibe et al., 2015). Our findings suggest that older adults may sacrifice immediate relief (e.g. via engaging with a more difficult regulatory strategy) for long-term benefits, such as increased self-efficacy or sense of resilience. That is, reappraisal may be implemented by older adults despite costs to hedonic outcomes in the present moment, driven by motivations that prioritize long-term socioemotional health. Indeed, prior findings suggest that task-specific motivations during emotion regulation may supersede hedonic desire to experience relieving emotions in the context of distress, in order to fulfill specific goals (Tamir, 2009, 2016). Perhaps our older adults were less focused on reducing emotional intensity or increasing positive affect in the moment, and open to reexperiencing distress related to AMs in order to employ the strategy accurately.

4.1 Disambiguating Uncued versus Cued AM Reappraisal Approaches

We hypothesized one of two outcomes for our AM-reappraisal conditions. In anticipation of cognitive load associated with linking unrelated memories to stimuli in the cued condition, an

unconstrained (uncued) memory search strategy would promote access to a broader repertoire of life experiences (Grilli et al., 2018; Gutchess et al., 2007; Kalenzaga et al., 2015). In contrast, we also hypothesized the possibility that supporting memory search with a cue would lower cognitive demands related to memory search processes, thus alleviating cognitive resources for integrating resilience narratives into reappraisals (Cuervo-Lombard et al., 2021; Martinelli et al., 2013; Uzer & Brown, 2017). Interestingly and consistent with our predictions, uncued reappraisals were less effective at reducing emotional intensity for older adults compared to younger adults, and no age effects were detected for the cued condition, suggesting reduced performance with unconstrained memory search for older adults only. In contrast, older adults benefited more, albeit marginally, from the cued approach compared to younger adults. Our findings may be explained by variability in access to cognitive resources with age. There is some agreement that older adults find non-AM reappraisal more taxing than younger adults (Opitz et al., 2012) and perceived effort and efficacy of reappraisal may depend on context and instructions (Lohani & Isaacowitz, 2014; Shiota & Levenson, 2009). Compared to a non-AM emotion regulation approach, AM integration increases working memory load (Conway & Pleydell-Pearce, 2000), particularly when unaided by a self-relevant cue (Eade et al., 2006; Sheldon et al., 2020). Older adults tend to shorten their search for relevant AMs, at stages where AM features are more abstract, compared to younger adults(Wank et al., 2021). Thus, searching for a salient and relevant autobiographical memory, similar to our *uncued* strategy, may require greater cognitive load, making this strategy more costly in effort for older adults. Burden of memory search was reduced in the *cued* condition, by providing participants with the self-generated AM cue and a self-paced preparatory slide.

On the other hand, cueing introduces a necessity to associate, or bind the target memory with the distressing situation, regardless of overlying similarity. Older adults historically demonstrate an associative binding deficit, but primarily when asked to retrieve highly specific details associated with prior life episodes (Addis et al., 2008) or for unrelated episodic features such as random picture pairs or rote word lists (Chalfonte & Johnson, 1996; Naveh-Benjamin, 2000; Naveh-Benjamin et al., 2003). Subsequently memory retrieval, accuracy, and specificity is impaired (Yonelinas, 2002). Importantly, this effect diminishes among older adults when accessing general, or gist autobiographical memories, such as knowledge relating to themes spanning a long time (i.e. "I am a cancer survivor"; "I had a long, successful career as an academic") (Conway & Pleydell-Pearce, 2000; Piolino et al., 2010). Moreover, providing AM cues supports faster construction of AMs, with more personal significance (Uzer & Brown, 2017). Therefore, when unconstrained by cognitive load of AM memory specificity, memory search, or timing burden, cognitive resources become more available to achieve task-directed goals (Sander et al., 2012)such as the goal to enhance positive affect in our task. In context to our study, older adults may have differentially benefited from cues of salient, self-relevant memories, relative to taxing, free memory search approaches, replicating past findings of age matched AM retrieval when cues are self-relevant (Cuervo-Lombard et al., 2021; Martinelli et al., 2013). However, it is worth nothing that older adults found the more cognitively taxing strategy, uncued reappraisal, to be more *helpful* and more *similar* to the image than the less demanding cued reappraisal strategy. Thus, being able to freely integrate memories with current stressors may be harder, but perhaps more natural, and helpful when integrating past memories to guide reappraisal.

As we predicted, older adults outperformed younger adults on the easiest reappraisal strategy, secondary to an equivalent performance on a strategy that reduced cognitive load of memory search (cued AM). However, age effects were most prominent in the uncued condition, lending support to the Compensation-Related Utilization of Neural Circuits Hypothesis (CRUNCH; Reuter-Lorenz & Cappell, 2008) that younger adults outperform older adults in tasks of highest cognitive burden. CRUNCH posits that any increasing task demands decrease efficacy with which older adults perform. In contrast, low task and/or cognitive demand produces equivalent, or minimally different performance, across age

Exploratory analyses of memory-image features produced surprising findings. Interestingly, greater memory to image similarity did not lead to reduction in emotional intensity, in contrast to our initial hypothesis. The opposite effect was demonstrated, such that greater memory to image similarity was associated with less change in emotional intensity. However, greater similarity was also associated with reduced difficulty to reappraise.

An explanation for this outcome may be driven by the emotional impact of recalling self-relevant resilience memories that induce vividness and salience of past challenging life experiences, inducing feelings of negative emotion. In our study, all participants initially recalled AMs of resilience episodes, during which they overcame challenging and emotionally laden experiences. Participants in AM-strategy conditions spent additional, self-paced time reflecting on these, or novel resilience memories, in preparation to reappraise, contributing to repetitive thinking of past experiences. Our overall pre- to post-task mood scores do provide some supporting evidence that merely engaging in the task lead to reduced positive affect, however this finding was consistent across all 3 conditions suggesting an effect of fatigue compared to emotional arousal. Consistent with prior literature, rumination— repetitive, cyclical *negative*

thinking over one's experiences or feelings— is linked to decreased mood (McLaughlin & Nolen-Hoeksema, 2011; Nolen-Hoeksema et al., 2008; Watkins & Roberts, 2020). Younger adults are especially prone to rumination compared to older adults as they reminisce over past experiences to guide future decisions (Ricarte et al., 2016). However, recent findings suggest that AM reminiscence plays a role in rumination, and the function of this role differs among older and younger adults in reducing negative affect. While younger adults utilize AMs in tandem with rumination to reduce negative affect in the context of social functions such as bonding with others, older adults utilize these strategies together to support directive functions, such as planning or problem solving (Bluck, 2003; J. J. Ricarte et al., 2020) laying further support to theoretical considerations of long-term motivations for self-relevant reappraisals among older adults. That is, rumination over past experiences is costly to mood in the moment, but may serve a taxonomy of functions in an adaptive way across age, including functions of social aptitude and problem-solving.

Taken together, our findings highlight that older adults are motivated to engage with self-relevant narratives of resilience during emotion regulation, relative to their younger counterparts, even when the strategies are particularly challenging to use. Older adults reported reappraising with greater ease, found greater similarities across their memories and negative stimuli, and found reappraisals more helpful. Future research may expand on these findings, evaluating the degree to which more life experience explicitly supports these unique reappraisal strategies, and clarify underlying motivations.

4.2 Limitations and Future Directions

Our study is not without limitations. Of most critical consideration, momentary cognitive resources and individual differences in cognitive control ability were not directly assessed due to

limitations of online data collection and task fatigue. Given the influence of cognitive control on AM recall (Conway & Pleydell-Pearce, 2000)and reappraisal (Ochsner & Gross, 2005), future research may replicate findings while also collecting cognitive assessments to clarify how availability of resources impact AM reappraisal efficacy and effort. Prior work suggests a moderating effect of fluid intelligence on reappraisal success among both young and older adults, as tracked by cognitive measures from the Wechsler Adult Intelligence Scale (e.g. Block Design, Coding, and Digit Span subtests) (Opitz et al., 2014). Replicating our results while concurrently tracking these cognitive measures may clarify 1). The role of access to cognitive resources in AM reappraisal use, and 2). differential role of cognitive control in non-AM relative to AM reappraisal approaches. Future research should aim to fill this important gap.

Our results also highlight that ratings of image intensity may not be sufficient in capturing emotion regulation strategy efficacy, which can involve more than momentary hedonic improvement ((Southward et al., 2021; Tamir, 2009, 2016). Additional objective measures of efficacy and emotion regulation motivations may clarify our findings further. This study was also based on self-reported measures of emotional intensity and difficulty, which are subject to substantial demand characteristics (McRae et al., 2012) and older adults demonstrate greater influence of these factors on responses in such tasks (Allard & Kensinger, 2014; Martins et al., 2018; Tucker et al., 2012). Self-reported emotional intensities *alone* do not factor for participant characteristics, leaving this singular measure of reappraisal success as insufficient to assess broader emotion regulation efficacy (McRae, 2013). Objective physiological measures of reappraisal success, such as change in amygdala activation, amygdala-ventromedial prefrontal cortex functional connectivity or heart rate variability, may more holistically and accurately capture reappraisal success (Ochsner et al., 2004). Similarly, pupillometry may provide a more

objective measure of effort during emotion regulation strategy use (Martins 2015). Finally, tracking alternative outcomes such as short versus long-term strategy adaptiveness and subsequent self-efficacy may guide understanding of emotion regulation motivation, above and beyond immediate strategy efficacy ((Southward et al., 2021).

Another limitation of our study is that participants were recruited from the internet using Amazon Mechanical Turk during the COVID-19 pandemic, a major threshold event with health-related restrictions and potential socioemotional implications, including differential influence of social isolation, anxiety, fear of contagion, chronic stress, and uncertainty across the lifespan (Birditt et al., 2021; Serafini et al., 2020). Although research suggests that data collected with this platform is relatively high in quality (Buhrmester et al., 2011), using an online sample may have influenced our results, including participant's motivations to engage in online research (i.e. unemployment) and positive reframing during a stressful and uncertain time. In line with this barrier, the paradigm was thoroughly piloted and training occupied an extensive amount of task time to completion. Timing restrictions and methodological concern of participant fatigue limited training time and resources. Unlike laboratory ("in-house") instructed paradigms of emotion regulation, real-time corrective feedback, discussion, and interpretation could not be implemented during task training. To minimize this potential limitation, feedback was included during training, however, this may not have been sufficient in correcting poor interpretation of task instructions. Future research may aim to replicate our findings in a lab-instructed environment with a representative community sample, where corrective feedback is readily available with a research associate. Increasing structured time around task training may reduce instructional ambiguity and subsequent errors in task completion.

Participants were randomly assigned to condition using a between-subjects design, limiting our interpretation. Participants were randomized into one strategy group and were not instructed to utilize both non-AM and AM reflection within the same trial timeline. Thus, it remains unclear if AM reappraisal may more effectively reduce intensity, above and beyond the benefit observed in the non-AM strategy condition. Similarly, we phrased one of our important dependent variables, perceived helpfulness, in a way that was specific to AM memories only, subsequently neglecting the perceived helpfulness of using a non-AM reappraisal. Future study designs may be amended to integrate a within-subjects manipulation of non-AM reappraisal *and* AM reappraisal, controlling for carry-over effects via condition randomization in a trial-by-trial or blocking approach. Such a design may clarify the benefit of AM reflection in reappraisal, above and beyond gold-standard approaches.

4.3 Broader Impacts and Conclusion

Taken together, our study introduced a novel concept with the goal of furthering theoretical models across fields of emotion regulation, autobiographical memory, and narrative psychology. Our findings provide a foundation for the benefit of incorporating self-relevant information during reappraisal, and nuance for age differences in the efficacy of this novel strategy. We further highlight a potential benefit of developing clinical interventions that align with and build upon affective strengths of older individuals. In this proof-of-concept study, we demonstrated that, in addition to non-AM reappraisal approaches, AM reappraisal is effective, and that cued reappraisal is equally effective for older and younger adults. Older adults found AM reappraisal to be less difficult, and their memories to be more overlapping with negative images in the study, paving promising motivation for exploring the role of resilience narratives in intervention in older adult populations.

While prior research emphasizes the role of AM in avoidance/distraction strategies of emotion regulation, our study is the first to assess whether integration of resilience AM narratives facilitates approach strategies such as reappraisal. It is clear that AM approaches are costly to employ, but our findings also provide initial evidence that they are helpful and effective to the regulation of momentary emotion via reappraisal. A rich body of future research may provide more context and clarification to our initial findings in this novel paradigm.

Tables

Table 1A. Sample demographics across age and condition.

	Older Adults (n=208)			Younger Adults (n=219)		
	Non-AM (n=83)	Uncued AM (n=76)	Cued AM (n=49)	Non-AM (n=73)	Uncued AM (n=77)	Cued AM (n=69)
Age[a]	65.88 (4.87)	65.43 (4.10)	65.49 (4.32)	25.25 (2.52)	25.03 (2.71)	24.94 (2.61)
Gender[a]	69% F	66% F	66% F	52% F	59% F	64% F
Race[a]	95% Caucasian	92% Caucasian	89% Caucasian	75% Caucasian	68% Caucasian	68% Caucasian
Asian	0 (0%)	0 (0%)	0 (0%)	6 (8%)	7 (9%)	6 (9%)
Black/African American	1 (1%)	1 (1%)	3 (6%)	6 (8%)	7 (9%)	9 (13%)
White	79 (95%)	70 (92%)	44 (90%)	56 (77%)	54 (70%)	47 (68%)
Bi-Racial	0 (0%)	4 (6%)	2 (4%)	4 (6%)	7 (9%)	6 (9%)
Other/Declined to respond	3 (4%)	1 (1%)	0 (0%)	1 (1%)	2 (3%)	1 (1%)
Ethnicity	99% NH	89% NH	94% NH	94% NH	89% NH	95% NH
Education[a]	15.48 (2.67)	15.14 (2.46)	15.51 (2.67)	14.85 (2.03)	14.92 (2.25)	14.45 (2.08)
Stress[a]	4.28 (2.19)	4.33 (2.09)	4.41 (1.93)	5.29 (2.25)	5.66 (2.19)	5.96 (1.82)
Health	6.61 (1.64)	6.67 (1.74)	6.22 (1.85)	6.63 (1.51)	6.23 (1.67)	6.33 (1.59)
Baseline Positive Affect	34.67 (6.67)	34.42 (6.87)	33.57 (5.82)	29.26 (7.78)	27.27 (8.54)	28.17 (8.06)
Baseline Negative Affect	12.31 (3.93)	12.68 (3.60)	14.04 (4.53)	13.05 (4.41)	12.89 (4.82)	13.98 (5.28)
Post Task Positive Affect	31.26 (6.96)	32.08 (8.02)	30.71 (6.93)	27.42 (8.49)	25.32 (8.40)	26.26 (8.48)
Post Task Negative Affect	13.76 (5.32)	14.28 (5.11)	14.18 (4.80)	15.32 (5.92)	15.24 (6.04)	15.63 (6.01)

Note: M(SD) unless otherwise reported, NH = Non-Hispanic. "Stress" and "health" were measured in a different session, before completing the study task. Bi-Racial categories included individuals representing Native Hawaiian/Pacific Island and American-Indian/Alaska Native races). Stress and health metrics were collected during prescreening, to capture perceived stress and physical health at that time point. Both were rated on a scale of 1 (very low stress/very poor health) to 9 (very high stress, excellent health). [a]Significant effect of age group; [b]Significant effect of condition; [c]Significant interaction effect of age group and condition

Table 1B. Task level outcomes across age and condition.

	Older Adults (n=208)			Younger Adults (n=219)		
	Non-AM (n=83)	Uncued AM (n=76)	Cued AM (n=49)	Non-AM (n=73)	Uncued AM (n=77)	Cued AM (n=69)
Baseline Intensity	6.82 (1.13)	6.73 (1.18)	6.77 (0.97)	6.01 (1.15)	5.96 (1.52)	6.20 (1.40)
Post-Reappraisal Intensity	5.70 (1.39)	6.45 (1.35)	6.20 (1.42)	5.42 (1.32)	5.44 (1.54)	5.69 (1.38)
Mean Efficacy[b,c]	1.16 (1.12)	0.31 (9.89)	0.57 (0.88)	0.61 (0.64)	0.45 (0.76)	0.51 (0.88)
Avg # of Missed Trials	1.16	2.46	5.21	1.16	2.45	3.49

Note. Outcomes reported as M(SD). Baseline intensity encompasses stimulus ratings prior to reappraising.
[a]Significant effect of age group; [b]Significant effect of condition; [c]Significant interaction effect of age and condition

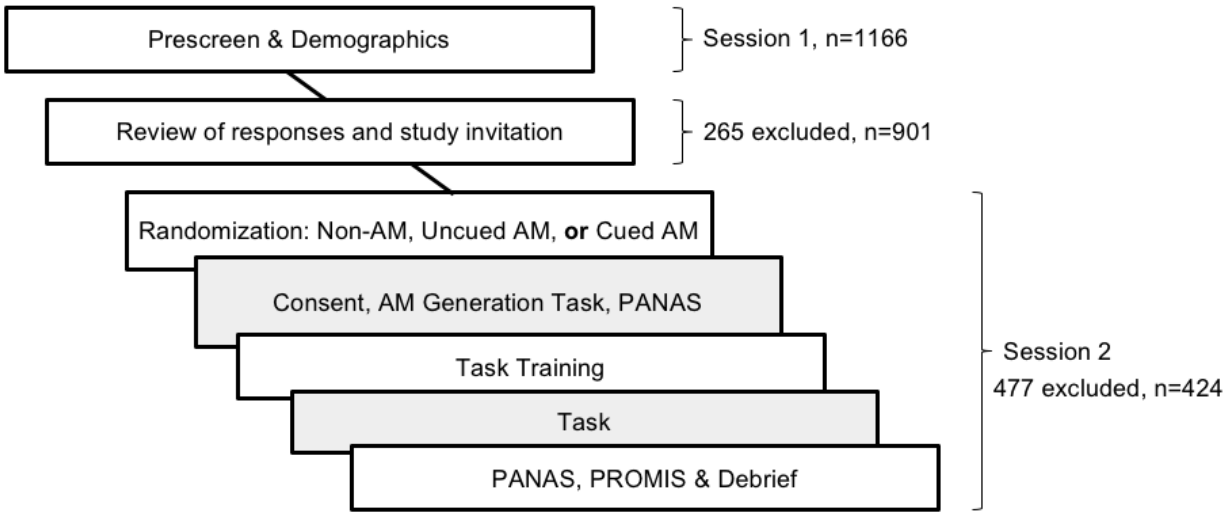
Table 2. Sample demographic functional health across age.

	Older Adults (n=207)			Younger Adults (n=217)		
	Non-AM (n=82)	Uncued AM (n=76)	Cued AM (n=49)	Non-AM (n=73)	Uncued AM (n=76)	Cued AM (n=68)
Sleep Disturbance[a]	48.85 (5.88)	50.38 (5.84)	51.05 (5.86)	52.02 (6.01)	52.38 (7.15)	53.02 (5.93)
Fatigue[a,b]	47.82 (8.99)	49.05 (10.1)	51.89 (8.77)	51.98 (9.82)	56.95 (9.58)	57.10 (8.14)
Anxiety[a]	50.66 (9.86)	51.44 (8.79)	52.06 (9.55)	56.01 (9.17)	58.76 (10.21)	59.45 (8.94)
Depression[a]	48.15 (8.76)	48.36 (7.60)	49.49 (8.95)	54.04 (9.57)	56.63 (11.39)	56.76 (9.15)
Physical Function[a]	47.41 (9.79)	48.41(10.11)	47.82 (9.91)	53.01 (7.20)	51.45 (8.32)	52.21 (7.41)
Pain[a]	49.89 (8.80)	51.91 (9.59)	50.68 (8.33)	47.47 (8.51)	47.86 (8.95)	49.02 (10.16)
Activity[a]	34.92 (7.72)	36.24 (8.02)	36.95 (8.26)	36.21 (7.36)	38.45 (8.99)	39.29 (7.85)

Note: PROMIS-29 outcomes, reported as M(SD).
[a]Significant effect of age group; [b]Significant effect of condition.

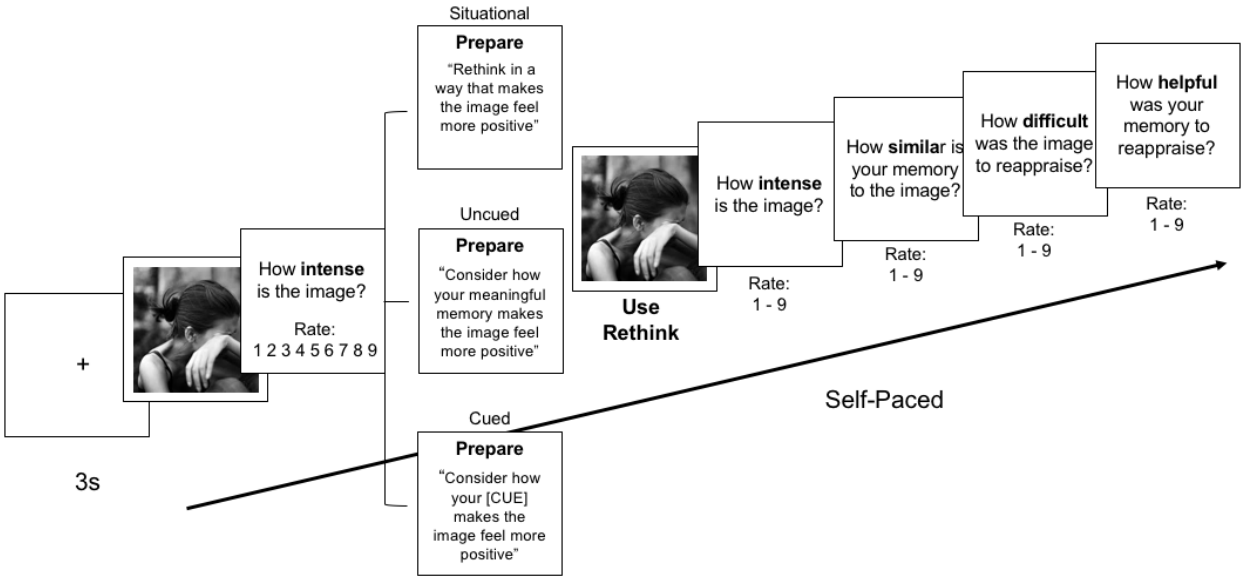
Figures

Figure 1. Study Timeline.



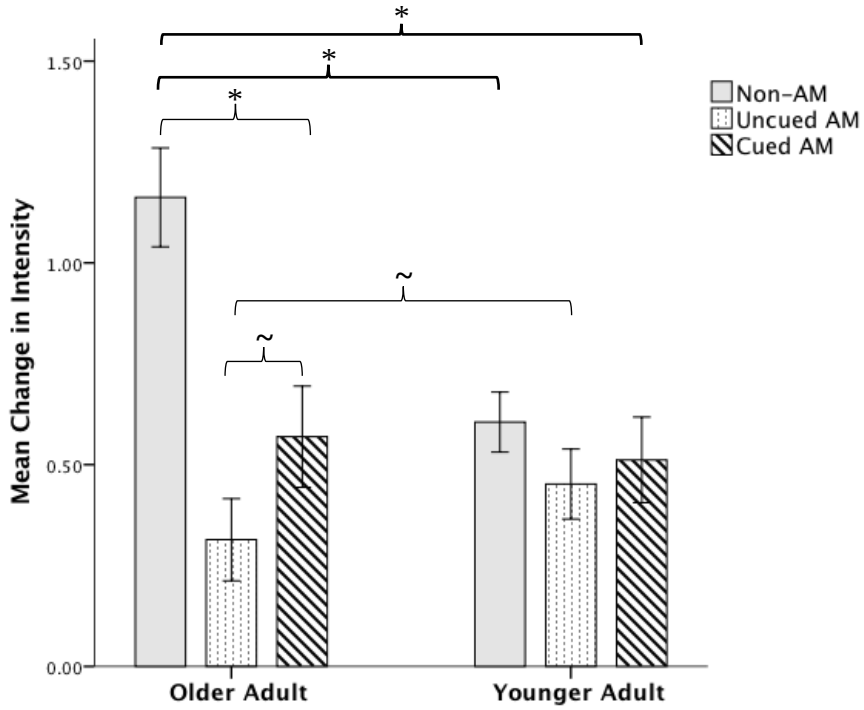
Note. Participants were prescreened based on a number of attentional checks, including Winograd questions and the Instructional Manipulation Check and completed demographic information. Those participants that sufficiently met attentional check criteria were invited to participate in the study and randomized into one of 3 between-subjects conditions. All participants completed an AM-generation task, mood measures, task training, and the emotion regulation task.

Figure 2. Emotion Regulation Task Timeline



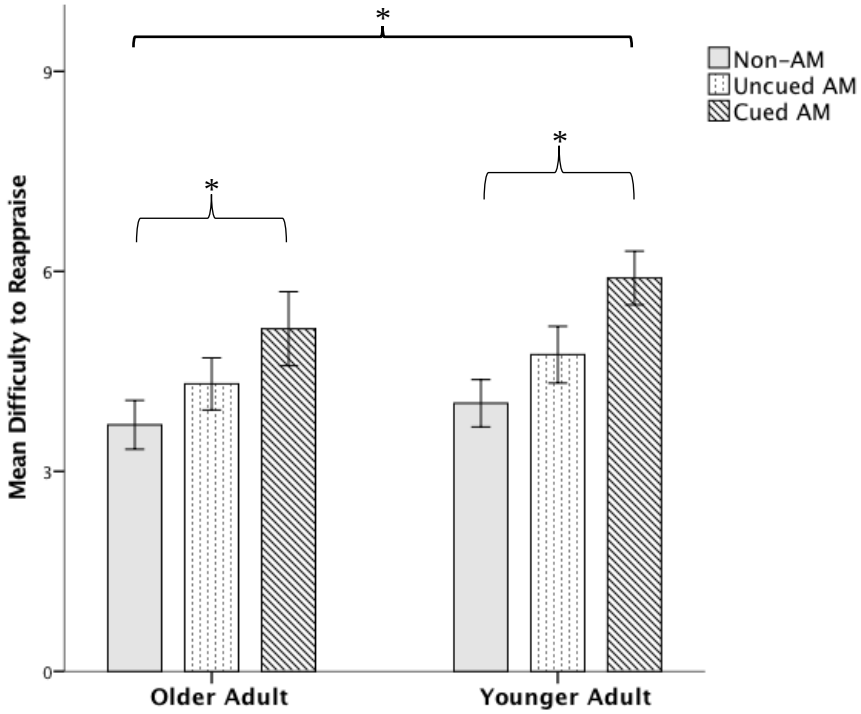
Note: Self-Paced = self-paced timing; S = seconds. Across three strategy conditions, participants completed an identical trial timeline. In the prepare slide, participants prepared their strategy in concordance with their trained strategy. In the situational condition, participants were to prepare and then use a reappraisal with no self-relevance. In contrast, AM conditions instructed preparation of *any* memory that may apply to the image (uncued), or preparation of a memory and self-generated cue from the AM generation task (cued).

Figure 3. Change in Intensity across Age and Reappraisal Strategy.



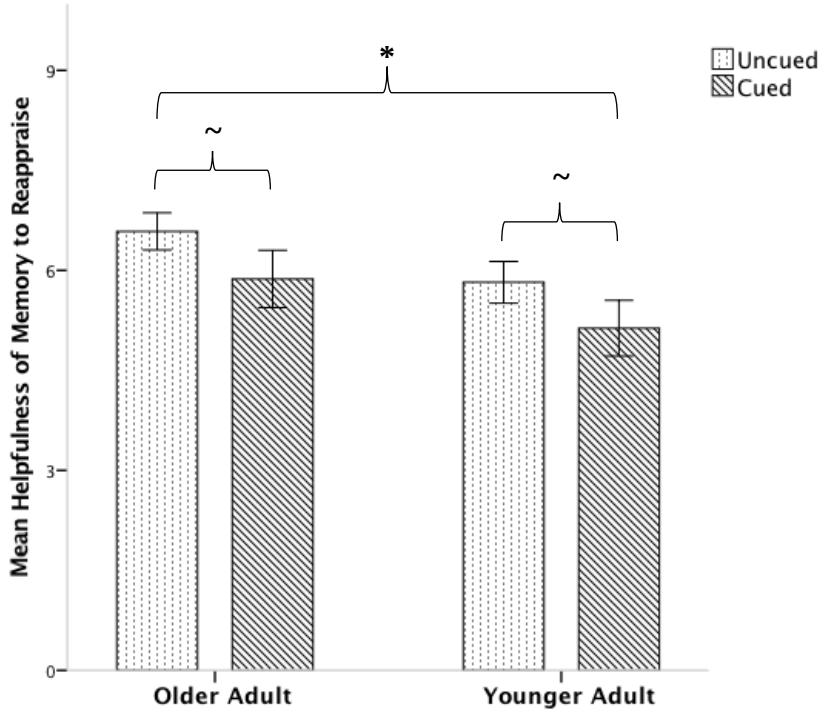
Note: Error bars represent standard error. Overall effects revealed an age by condition interaction that was driven by older adults. While younger adults demonstrated no difference of benefit across emotion regulation strategies, non-AM reappraisal was most effective for older adults. A trend was observed among older adults, such that cued AM reappraisal was more effective than uncued AM reappraisal, at reducing emotional intensity. Similarly, a trending age effect was detected such that older and younger adults demonstrated equivalent efficacy with used of cued AM reappraisal, but use of the uncued AM reappraisal was more effective for younger, over older adults. * $p < 0.01$; ~ p = trending.

Figure 4. Average Difficulty to Reappraise Modeled Across Age and Reappraisal Strategy.



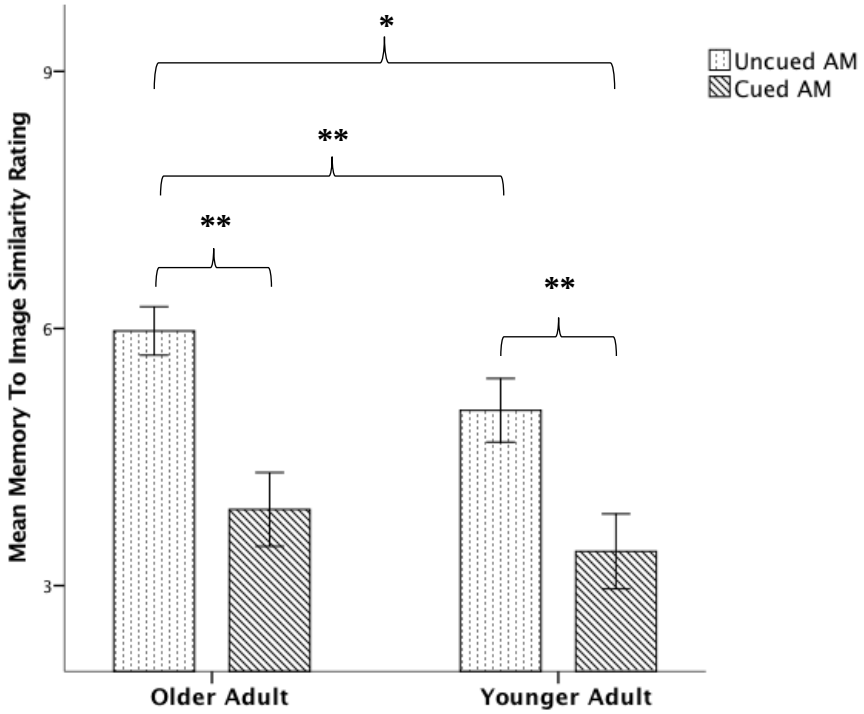
Note. Error bars represent standard error. A main effect of age revealed that younger adults found all reappraisals more challenging to employ compared to older adults. Across age, a main effect of condition demonstrated a step-wise effect such that Non-AM reappraisals were easiest to use, followed by uncued AM reappraisals, and cued AM reappraisals, respectively.
** $p < 0.001$; * $p < 0.01$.

Figure 5. Average Helpfulness Rating Across Age and Condition



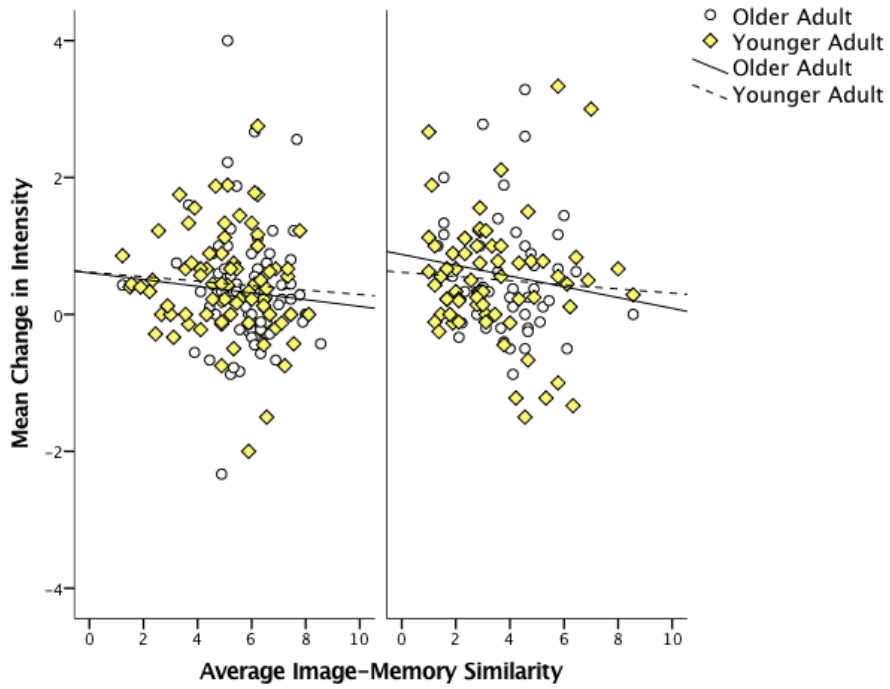
Note. Error bars represent standard error. Older adults found AM reappraisals more helpful relative to their younger counterparts. Uncued AM reappraisals were marginally more helpful than cued AM reappraisals.
Av

Figure 6. Average Similarity Rating Across Age and Condition.



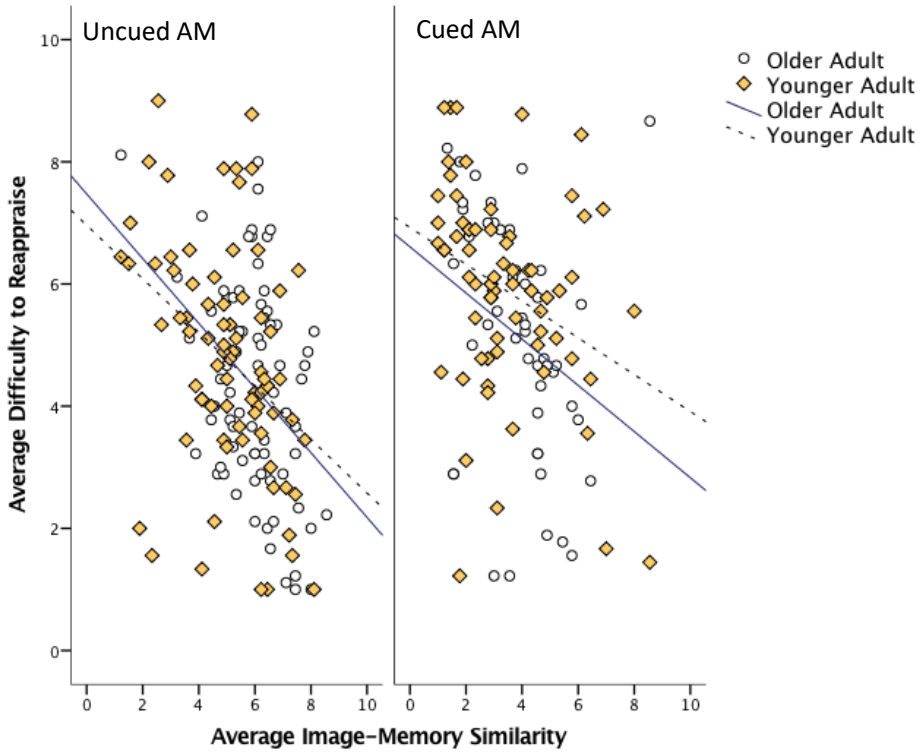
Note. Error bars represent standard error. A significant effect of age revealed that older adults found greater shared similarity between their memories and stimuli compared to younger adults. Uncued memories were significantly more similar to the stimuli than cued memories, based on self-report.
** = p< 0.001, * = p<0.05

Figure 7. Association Between Perceived Memory to Image Similarity and Mean Change in Intensity Across AM Strategies.



Note. Linear regressions revealed a significant association between AM to image similarity and mean change in stimulus intense, post reappraisal. Across conditions, greater memory to image similarity was related to less change in image intensity, and this effect was consistent across age.

Figure 8. Association Between Perceived Memory to Image Similarity and Difficulty of Reappraisal Across AM Strategies.



Note. Linear regressions revealed a significant association between AM to image similarity, and degree of difficulty to reappraise. Across conditions, greater memory to image similarity was related to easier use of reappraisals for both AM conditions.

Appendix A. Winograd questions (Levesque, Davis and Morgensterm, 2012)

1. Paul tried to call George on the phone, but he wasn't successful. Who wasn't successful?
    a. Paul
    b. George

2. I poured water from the bottle into a cup until it was full. What was full?
    a. The cup
    b. The bottle

3. John couldn't see the stage with Billy in front of him because he is so tall. Who is so tall?
    a. John
    b. Billy

4. Although they ran at about the same speed, Sue beat Sally because she had such a bad start. Who had a bad start?
    a. Sue
    b. Sally

5. Joan made sure to thank Susan for all the help she had given. Who received help?
    a. Susan
    b. Joan

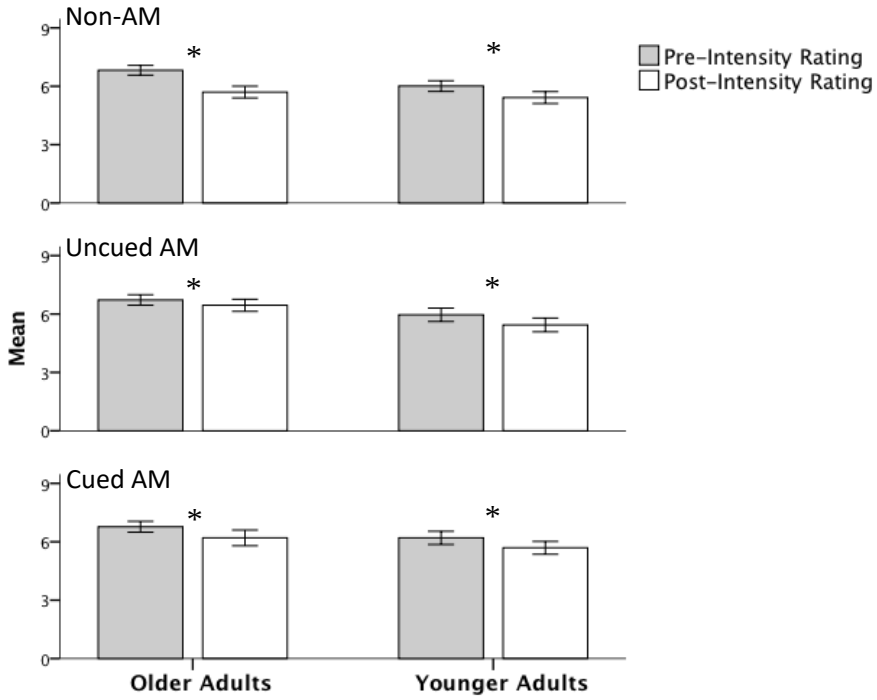
Appendix B. Task Instructions by Condition

Participants were instructed accordingly, based on the condition into which they were randomized:

[Control] ***Non-AM***:	"When you **rethink**, focus on what you see and try to reinterpret the image in a way that makes it feel more positive. Consider how the situation will be okay in the end, or **rethink** by considering that the situation is only temporary. Remember, as you **rethink**, find a silver-lining in the image, so that the image feels more positive."
Uncued AM:	"As you **rethink**, find the silver-lining in the image by **relating it to any meaningful memory that relates to the image.** Consider how the situation will be okay in the end, similar to your own meaning memory. **Rethink** by relating the image to what your meaningful memory taught you, how it turned out better than you expected, or that you preserved through a challenging event, in the end. You will be asked to use one of your meaningful memories to **rethink** the image. Consider how that memory could apply to the situation in the image, so the image feels more positive.
Cued AM:	"As you **rethink**, find the silver-lining in the image by **relating it to the meaningful memory you remembered today.** Consider how the situation will be okay in the end, similar to your own meaning memory. **Rethink** by relating the image to what your meaningful memory taught you, how it turned out better than you expected, or that you preserved through a challenging event, in the end. You will be asked to use one of your meaningful memories to **rethink** the image. Consider how that memory could apply to the situation in the image, so the image feels more positive.

Note. Participants in the Cued AM condition were cued to recall the same memory for each block of three image trials, with memory order randomized across blocks. That is, the same memory was to be utilized for trials 1-3 of each block, randomizing the generated memory across blocks.

Appendix C. Mean Rating of Image Intensity Before and After Regulating, Across Age and Emotion Regulation Strategy



Note. Error bars represent standard error. Both older and younger adults benefited from all 3 conditions, in reducing image intensity, however, pre and post intensity ratings did not differ across conditions.
* $p < 0.001$.

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