

## CHAPTER 6: GENERAL DISCUSSION

*Although many challenging questions remain, understanding emotion-cognition interactions at multiple levels of analysis is a realistic and exciting scientific goal.*

Jeremy R. Gray, 2004

This dissertation examined suggestions that older adults show a memory advantage for positively-toned material (i.e., positivity effect, Charles et al., 2003). A *heterogeneity-homogeneity list paradigm* was developed to disentangle two explanations for the positivity effect, processing prioritization and general memory processes for negative, positive, and neutral material. Specifically, I examined memory performance for positive, negative, and neutral words in two list conditions that differently afford processing prioritization: an emotion-heterogeneous list condition that highlights differences between valence categories and an emotion-homogeneous list condition that minimizes differences between valence categories. These list conditions allowed me to test whether there were age-related differences in differential processing prioritization of emotionally-toned words, particularly whether older adults prioritise positive information over negative information and more so than young adults. In addition, in a multi-trial free recall task, I examined differential learning and retention effects for positive, negative, and neutral words.

This chapter discusses the major findings of the experiment (see *6.1 Major Findings*) in relation to previous studies and the theoretical work that guided the study. Potential methodological caveats are outlined (see *6.2 Methodological Caveats*) and directions of future research described (see *6.3 Directions for Future Research*).

### 6.1 MAJOR FINDINGS

The goal of the present dissertation was to investigate two major research questions: First, are there age-related differences in the positive-negative disparity of emotional memory? Specifically, do older adults remember positive material better than negative material? This research question was based on recent suggestions in the social-cognitive aging literature: Some authors propose that older adults prioritize positive over negative information in memory and more so than young adults (e.g., Charles et al., 2003). The empirical evidence for this positivity effect is, however, inconsistent. Some studies find this effect whereas others do not. The second major research question was based on the idea that the positivity effect may be due to differential processing prioritization for emotionally-toned material and age differences in prioritization. If such prioritization exists, then it was

proposed that there should be a differential recall pattern in the emotion-heterogeneous and emotion-homogeneous list conditions that would be suggestive of emotion-based processing prioritization.

To address these research questions, I investigated the free recall performance of young and older adults for the same sets of words presented either in an emotion-heterogeneous (positive, negative, and neutral words together) or an emotion-homogeneous list condition (separate presentation of positive, negative, or neutral words). The heterogeneity-homogeneity list paradigm was derived from research that showed memory differences between content categories in mixed (heterogeneous) but not in unmixed (homogeneous) lists (e.g., Einstein & McDaniel, 1987; McDaniel et al., 2000). The general idea was that the distinctive nature of one content category (e.g., negative words) relative to another category (e.g., positive words) might attract more elaborative processing in an emotion-heterogeneous context that highlights differences than in an emotion-homogeneous context, which minimizes differences. I used this paradigm because it allowed me to test different explanations for a positivity effect in older adults: On the one hand, a positivity effect in older adults' memory might be due to a preference of positive over negative material during information processing. On the other hand, a positivity effect can reflect general memory differences in the storage of positive and negative information. If a positivity effect in older adults' memory were due to a processing priority of positive information above negative information, one would expect to observe a positivity effect in an emotionally-heterogeneous context but not within an emotionally-homogeneous context. In contrast, young adults' memory should show no positivity effect in both contexts. Such a differential pattern of age-by-condition interaction would document selective processing prioritization of positive material in older adults. Alternatively, if a positivity effect in older adults' memory were due to more general processes operating in remembering positive and negative information, as suggested by Mather et al. (2004), one would expect to observe a positivity effect in both emotionally-heterogeneous and emotionally-homogeneous contexts.

A recall task rather than a recognition task was employed because of two reasons. First, age differences are typically more pronounced under the cognitive more demanding free recall task than under simple recognition tasks (Kausler, 1994; N. White & Cunningham). Thus, the detection of age-related differences in remembering positive and negative words might be maximized under a free recall rather than recognition task. Second, list context effects between mixed (i.e., heterogeneous) and unmixed (i.e., homogeneous) lists are typically stronger for free recall tasks than recognition tasks (e.g., Ratcliff et al., 1990). In

conclusion, a free recall task maximizes the possibility to find differences between age groups and list conditions.

Specifically, in a multi-trial free recall task, 72 young (aged 18 to 31 years) and 72 older adults (aged 64 to 75 years) were asked to recall 30 words under an emotion-heterogeneous or emotion-homogeneous list context. The sample was stratified by sex and educational levels. To facilitate the comparison between young and older adults, five study and recall trials were introduced into the design. This was done to avoid floor effects in the recall data, to increase power to detect an Age x Valence interaction, and to examine learning rates for positive, negative, and neutral material. To my knowledge, no prior study has investigated differential learning rates for positive, negative, and neutral material. In addition, to examine age-related differences in long-term memory for emotionally-toned material, two different retention intervals were used (i.e., 1-hour and 1-week retention interval). This was done in order to examine whether the positivity effect in older adults' memory is time sensitive.

In order to control for age-related differences in the perception of the to-be-remembered material and for differences between positive, negative, and neutral material in memory-relevant characteristics, it was important to employ words where the characteristics were well-known. To begin with, I decided to use adjectives rather than nouns, because adjectives are typically less variable in their semantic meaning than nouns resulting and adjectives are naturally related to emotions (e.g., "happy") that should facilitate the processing of the affective connotation. Therefore, the use of adjectives should reduce the amount of noise (i.e., error variance) in the data. To assess central characteristics of the adjectives, information about emotion-relevant (i.e., valence, arousal, control), memory-relevant (imagery, word frequency, word length), and self-relevant (i.e., age-relevance, self-relevance) characteristics were collected. The memory material was selected on the basis of rating data obtained in the preparatory Word Rating Study (see Chapter 4). Twenty-four young (aged 20 to 30 years) and 24 older adults (aged 65 to 76 years) were asked to rate 200 adjectives on six dimensions: valence, arousal, control, imagery, age-relevance, and self-relevance. Based on these ratings, 30 negative, 30 positive, and 30 neutral words were selected as to-be-remembered material for the experiment. Words were equated for word frequency, word frequency class, word length, imagery, and age-relevance. Sets of positive and negative words were also matched on emotional intensity. Moreover, the valence ratings by young and older adults did not differ for the selected set of to-be-remembered material.

The outcome was clear-cut. Table 32 provides an overview of the research predictions and outcomes. First, I found no age differences in remembering positive and negative words. This was the case within both the emotion-heterogeneous and the emotion-homogeneous list condition. This null finding did not support proposals about a preference of positive over negative information in older adults' memory (see Hypothesis 1). There was no evidence that this trend changed over the five repeated learning trials (see Hypothesis 4) or the two long-term retention intervals. In addition, the pattern of findings remained after having controlled for interindividual differences in sociodemographic (i.e., chronological age, years of education), intelligence (i.e., reasoning, perceptual speed, vocabulary), personality (i.e., Big Five dimensions), and affective factors (i.e., current mood, negative trait affect, positive trait affect; see Hypothesis 5). This finding is important with regards to the quasi-experimental nature of the experiment: Young and older adults not only differ in chronological age but might as well differ in memory-relevant and affect-related characteristics. Furthermore, a corresponding pattern of findings was evident by using subjectively generated valence categories for each participant rather than a priori valence categories (see Hypothesis 6). As revealed by the Word Rating Study (see Chapter 4), age groups differed greatly in the emotional perception of words. The analyses on the subjective generated valence categories took interindividual differences in the subjective perception of the to-be-remembered material into account. Taken together, there was no evidence for the proposed positivity effect in older adults' memory.

Second, I found a differential pattern of recalling positive and negative material across the two processing contexts. In the context with strong cues for processing prioritization (i.e., emotion-heterogeneous context), participants recalled more negative than positive words and more negative than neutral words, whereas in the context with no cues for processing prioritization (i.e., emotion-homogeneous context), participants who only learned positive words recalled more than those who only learned neutral words. However, there was no difference in the recall for emotion-homogeneous lists of positive and negative words. This finding in the heterogeneity-homogeneity list paradigm is consistent with the idea that negative information is prioritized in information processing when positive and negative information compete on processing resources, that is, when positive and negative information are presented simultaneously within one list (see Hypothesis 2 and Hypothesis 3).

Table 32

*Overview of Central Research Predictions and Main Findings**Main Prediction in the Learning Phase*

H1) Older adults are expected to recall more positive than negative words in the emotion-heterogeneous list condition.	No
H2) In the emotion-heterogeneous list condition, negative words are better recalled than positive words.	Yes
H3) Emotion-homogeneous lists of negative and positive words are equally well recalled.	Yes
H4) Effects are magnified by increasing learning opportunities.	No
H5) Effects are <u>not</u> mediated by person characteristics (rather than age).	Yes
H6) Effects are <u>not</u> mediated by subjective perceived valence.	Yes
H7) Effects are also <u>not</u> mediated by word characteristics.	Yes

*Main Predictions in the Retention Phase*

H8) With longer retention intervals, memory differences between neutral and emotional words are magnified.	No
H9) With longer retention intervals, memory for negative words, in contrast to positive words, show steeper forgetting curves.	No

*Note.* The last column indicates whether the prediction was supported by the findings of the present experiment.

Third, within both list conditions, I found no evidence for differential recall patterns between young and older adults for positive, negative, and neutral words. The analyses of recall of 10-item word sets and of recallability scores, however, revealed a more differentiated picture. Young adults showed strong contextual effects: They recalled more negative and neutral words and fewer positive words in the heterogeneous list condition than in the homogeneous list condition. The overall pattern was similar for older adults but, unlike the young adults, their recall discrepancy scores were not significantly different from zero. This suggests that older adults did not use differential processing prioritization as much as young adults. The effects on the recall of words were basically unchanged after controlling for the subjective ratings of the participants for the to-be-remembered material. The pattern of findings for the recall discrepancy scores suggests that young adults were more sensitive to these context-dependent encoding processes than older adults. These findings highlight the value of the heterogeneity-homogeneity list paradigm in determining processes that are not visible when investigating memory in an emotion-heterogeneous or an emotion-homogeneous list context alone.

Finally, I found no evidence for differential learning or retention rates for positive, negative, and neutral material in both conditions and in both age groups. I introduced five repeated learning trials to examine age-related differences in intraindividual plasticity (e.g., Baltes, 1987) for positive, negative, and neutral words. The general idea was that age differences magnify with increasing learning opportunities. Thus, if a positivity effect in older adults' memory exists, I expected that the magnitude of this effect increased across the learning trials. However, I did not find evidence for a positivity effect in older adults and consequently no evidence for a change of this null finding over the repeated learning opportunities. In addition, the use of multiple learning and recall trials has methodological benefits such as the increase in power to detect an Age x Valence interaction. To my knowledge, this is the first study that investigated learning rates for positive, negative, and neutral words.

Regarding the retention data and contrary to expectations, I found no evidence for the idea that the memory enhancement effect by emotion magnifies with increasing retention interval (see Hypothesis 8). Moreover, I found no evidence for the idea that negative words show faster decay than positive words (see Hypothesis 9).

### **6.1.1 Advantages of the Heterogeneity-Homogeneity List Paradigm**

The heterogeneity-homogeneity list paradigm provides a means to investigate the effects of processing prioritization on memory for emotionally-toned words. Although the heterogeneity-homogeneity list paradigm does not directly allow the study of processes, the variation of list compositions does produce some insight into the memory processes involved. In the present dissertation, I varied the emotional tone in emotion-heterogeneous and emotion-homogeneous lists. Specifically, the heterogeneity-homogeneity list paradigm is instructed by experimental research investigating memory differences between content categories in mixed (heterogeneous) and unmixed (homogeneous) lists (e.g., Einstein & McDaniel, 1987; McDaniel et al., 2000). This line of research consistently shows that the distinctive nature of one content category relative to another content category attracts more processing in a mixed context than in an unmixed context. In a mixed, emotion-heterogeneous context, positive and negative information compete for limited processing resources. If one valence category is prioritized in the processing, this category should reveal enhanced remembrance. In an unmixed, emotion-homogeneous context, in contrast, positive or negative information cannot be prioritized over the other. Thus, the list context cues emotion-based prioritization.

In the heterogeneity-homogeneity list paradigm, the same to-be-remembered material is used in both list conditions. Thus, differences between list conditions cannot be due to differences in the to-be-remembered material. However, a different memory pattern in the emotion-heterogeneous and emotion-homogeneous contexts suggests that memory processes rely, at least partly, on the composition of the to-be-remembered material. This context effect indicates valence differences in processing prioritization. With the heterogeneity-homogeneity list paradigm, it is possible to examine age-related differences in emotion-based processing prioritization. Taken together, the multi-trial heterogeneity-homogeneity list paradigm is a means to change the focus of research more in the direction of processes rather than simple outcomes.

### **6.1.2 Advantages of the Multi-Trial Paradigm**

In past research about memory and emotion, learning and long-term retention effects have not received much attention. These design features were introduced based on lifespan concepts in cognitive aging research (e.g., Baltes, 1987; Baltes et al., 2006). Although these aspects have been central in general research on memory, there is, to my knowledge, no study available that has investigated learning rates for positive, negative, and neutral material. To begin a systematic investigation of the enhancement of memory by emotion, I examined the influence of both learning and retention effects. I used a multi-trial design to examine learning rates for emotionally-toned words. Moreover, to investigate differential retention for positive, negative, and neutral words, I used two different retention intervals: 1-hour and 1-week recall intervals.

The multi-trial design has theoretical and methodological advantages. The theoretical advantage was inspired by research investigating age-related differences in intraindividual plasticity in cognitive performance (e.g., Baltes et al., 1988; Baltes & Lindenberger, 1988; Baltes & Willis, 1982; Verhaeghen et al., 1992). In this line of research, Baltes, Kliegl, and Smith used in a set of studies a testing-the-limits paradigm to investigate age-related differences in reserve potentials in memory performance (Baltes & Kliegl, 1992; Kliegl, Smith, & Baltes, 1989, 1990). The findings show that older adults have reserve potentials but that there are as well age-related limits of plasticity. In light of this research, the use of multiple trials in the present experiment can give some suggestions for age-related differences in remembering emotional material at the limits of performance. Specifically, if a preference for positive over negative information in older adults' memory exists and more so than in young adults' memory, these age differences in the relative remembrance of positive

and negative material should increase at the limits of plasticity. To obtain initial empirical evidence on this topic, five repeated learning trials were introduced to the design. However, the present study did not use genuine testing-the-limits paradigm. (Recall performance was not at the limits of memory performance.) This was the case because the focus of the experimental design was on optimizing the heterogeneity-homogeneity list paradigm. Nevertheless, the multi-trial design can give rise to theoretical or experimental ideas in future research.

At least two aspects showed the methodological advantage of the multi-trial design. On the one hand, multiple study and recall trials avoid floor effects in the recall data that could bias the analyses. On the other hand, a multi-trial design increases the power to detect an Age x Valence interaction. Despite the fact that the present dissertation did not reveal a positivity effect in older adults' memory, the multi-trial paradigm facilitated the detection of a potential positivity effect.

### **6.1.3 Evidence for a Positivity Effect in Older Adults' Memory?**

The objective of this dissertation was to examine recent suggestions in the social-cognitive aging literature about a positivity effect in older adults' memory (e.g., Charles et al, 2003). Specifically, the research question was whether older adults remember more positive than negative information relative to young adults. That is, an age-related difference in remembering positive and negative information. This proposed positivity effect is thought to be due to an increase in the salience of emotion and enhanced emotion regulation capacities in older adults. Thus, the proposed positivity effect is interpreted as a sign of improved emotion regulation in old age.

In contrast to this recent suggestion, the present dissertation did not reveal any evidence for a positivity effect in older adults' memory for emotionally-toned words. In both list conditions, older adults, relative to young adults, did not recall more positive than negative words. In the emotion-heterogeneous list condition, both age groups recalled more negative than positive words. In the emotion-homogeneous list condition, there was a non-significant trend for the opposite pattern: Young adults recalled more words in the positive than in the negative emotion-homogeneous list; in contrast, older adults recalled an equal number of words in the positive and negative emotion-homogeneous lists. Additionally, there was no evidence for age-related differences in remembering emotionally-toned words across a 1-week period. Specifically, there was no evidence for an advantage of older adults' memory for positively-toned words in both list conditions. Thus, this finding did not support



potential speculations that the proposed positivity effect might be evident only in long-term memory.

In this controlled experiment, I assessed several person and word characteristics that may influence memory performance. This allowed me to set apart a number of alternative explanations for the obtained findings than the variation of the emotional tone of the words. For example, differences between list conditions and age groups might be due to group differences in person characteristics that influence memory performance as well such as current mood. Person characteristics were assessed that are related to memory (i.e., fluid and crystallized intelligence) and emotional functioning (i.e., current mood, trait affect). Similarly, word characteristics were assessed with regard to (a) general recallability (i.e. frequency, length, imagery), (b) emotion-specific attributes (i.e., valence, arousal, control), and (c) self-relevant characteristics (i.e., age-relevance, self-relevance). Neither person nor word characteristics had a strong impact on the obtained effects. After controlling for these characteristics, all valence effects remained significant documenting the robustness of the obtained findings. Moreover, there was no evidence for additional effects after entering these characteristics as covariates. In particular, there was no evidence for the proposed positivity effect in older adults' memory.

#### **6.1.4 Evidence for Emotion-Based Processing Prioritization**

Across many psychological domains, there is considerable evidence in the literature that negative entities (e.g., events, objects, information) have a much greater impact than positive entities (for reviews see Baumeister et al., 2001; Rozin & Royzman, 2001; Taylor, 1991). Pratto and John (1991) argue, for example, that negative information might attract more processing resources than positive information because the detection of negative stimuli is more critical for survival and well-being than the detection of positive information. This priority of processing negative information reduces the resources available to process other stimuli simultaneously: that is a tendency for *emotion-based processing prioritization for negative information*.

If differential processing prioritization of emotionally-toned material plays a major role in memory for emotionally-toned material, negative information should be better remembered in an emotion-heterogeneous list context but not in an emotion-homogeneous list context. Indeed, the present experiment provided empirical support for the proposed pattern in the heterogeneity-homogeneity list paradigm. This finding illustrated the general influence of differential processing prioritization in memory for emotionally-toned material.

An alternative explanation for the differential pattern of findings in the emotion-heterogeneous and emotion-homogeneous lists is related to differences in retrieval cues given by the list category. All words in an emotion-homogeneous list shared, by definition, a similar emotional tone. Participants in the emotion-homogeneous list conditions might have realized this shared feature and generated emotion-congruent words in their recall. For example, participants in the positive homogeneous list condition might have generated positive adjectives without knowing whether or not these words were on the list. By using this strategy, participants might have produced some correct hits. Moreover, the ease to generate words might differ between valence categories. In the emotion-heterogeneous list condition, in contrast, a similar retrieval cue for the generation of adjectives was not available. These differences in retrieval cues might explain the differential pattern of findings in the emotion-heterogeneous and emotion-homogeneous lists. One finding speaks against this explanation: If participants used the emotional tone in the homogeneous lists to generate words, and if they were more likely to generate hits by using this strategy, participants should show better recall in an emotion-homogeneous than in an emotion-heterogeneous list. However, participants in both list conditions did not differ in total recall performance.

There was one unexpected finding: When the different valence categories are not in competition with each other (i.e., emotion-homogeneous lists), I found that both young and older adults remembered more positive than neutral words. If this effect indicates a general enhancement of memory by emotion, the question arises why the recall for the homogeneous lists of negative and neutral words did not differ. The memory advantage for the positive words could also be a function of differences in the specific word characteristics (other than length, frequency and imagery) of the items I used. For example, the positive words might have been more easily discriminated. Despite the careful selection of the to-be-remembered material in the Word Rating Study (see Chapter 4), it might well be that positive words showed more beneficial characteristics than neutral words. Another explanation might be that positive, negative, and neutral words differ in subjective semantic relatedness (e.g., Talmi & Moscovitch, 2004). Thus, it might be easier to encode and generate positive words than neutral words. Further studies are needed to replicate this finding with regard to emotion-homogeneous lists and to determine the reasons for this trend.

### **6.1.5 Age-Related Differences in Differential Processing Prioritization**

In comparing the recall performance for positive, negative, and neutral words in the emotion-heterogeneous and emotion-homogeneous list condition, I found an age-related

difference in emotion-based processing prioritization. Young adults' recall pattern differed substantially for the heterogeneous and homogeneous list condition whereas older adults' recall pattern was similar in both list conditions. This finding is interpreted as evidence for less emotion-based processing prioritization in older adults.

There are several interpretations for the age difference involving a lesser (or even no) differential processing prioritization. One explanation is that older adults display more emotion regulation in general which, in turn, could downplay the role of the emotional-tone variation in the design. This view would be in line with the work of Carstensen and colleagues (e.g., Carstensen, Isaacowitz, & Charles, 1999). Note, however, that such an interpretation requires independent evidence about the existence of an age advantage in emotion regulation that was not available in this dissertation project. If emotion regulation plays a role, the recall data in the present study suggest that older adults not only down-regulate the negative tone but also the positive tone of the to-be-remembered words.

Other interpretations are driven more by accounts of cognitive aging. The reduced context-sensitivity in old age, for example, could be due to an age-related limitation in processing resources (e.g., Salthouse, 1991, 1996). This explanation implies that older adults are less able to regulate attentional processes due to a limitation in available processing resources (i.e., speed, working memory). This assumption that resource limitations are implicated in processing social information is common in social cognitive research (e.g., Hess, 1994; Schwarz, Park, Knäuper, & Sudman, 1999). In the case of high cognitive demand, processing resources available to invest in elaborative processing of social information are reduced. Thus, age-related differences in differential processing prioritization might depend on interindividual differences in processing resources. In this experiment, I found no evidence for the moderating role of interindividual differences in cognitive abilities in the obtained effects of valence. Covariate analyses controlling for levels of intellectual functioning reduced age-related differences in total memory performance but did not alter the Age x Valence interaction. This was the case for fluid (i.e., speed, reasoning) as well as crystallized (i.e., vocabulary) indicators of cognitive abilities. Thus, there was no evidence that memory for emotional words was influenced by cognitive processing resources.

One possible explanation for this reduced context-sensitivity in old age could be a diminished ability to discriminate emotional information. This explanation is supported by studies investigating age differences in recognizing facial signals of emotions (Calder et al., 2003; Malatesta, Izard, Culver, & Nicolich, 1987; Moreno, Borod, Welkowitz, & Alpert, 1993). These studies consistently find that accuracy in recognizing emotional faces is reduced

in old age. This finding is also consistent with evidence from fMRI research on age-related differences in the neural circuitry involved in processing of affect. This line of research suggests age-related changes from more subcortical (i.e., amygdala) to more cortical (i.e., insular cortex) activations during processing of the emotional tone of faces (e.g., Fischer, Sandblom, Gavazzeni, Ransson, Wright, & Bäckman, 2005; Gunning-Dixon et al., 2003). Moreover, some authors argue for a reward-related activation of dopaminergic midbrain that is associated with enhanced memory (Wittmann, Schott, Guderian, Frey, Heinze, & Düzel, 2005). There is consistent evidence for substantial decline in dopamine with age (Bäckmann, Nyberg, Lindenberger, Li, & Farde, in press). This decline in dopamine might also result in a diminished ability to discriminate affective information. An alternative explanation for the reduced context-sensitivity in older adults' memory could be provided by the distinction between two encoding strategies: item-specific processing and relational processing (e.g., Einstein & Hunt, 1980; Hunt & McDaniel, 1993). There is some evidence that older adults rely more on item-specific processing than on relational processing (e.g., Hultsch, 1969; Rankin & Firnhaber, 1986). If this were the case, older adults would show a similar recall pattern irrespective of the surrounding context. However, if young adults rely more on relational processing, it is not clear how the observed recall pattern could have resulted. Future studies are needed to disentangle different explanations for the diminished use of differential processing prioritization of emotionally-toned material in older adults.

At a first glance, the general finding of no positivity effect in older adults' memory is inconsistent with studies that show a positivity effect (Charles et al., 2003; Knight et al., 2002; Leigland et al., 2004; Experiment 2 of Mather & Carstensen, 2003). It is, however, consistent with other studies that do not find such a effect (Comblain et al., 2004; Denburg et al., 2003; Kensinger et al., 2002; Experiment 1 of Mather & Carstensen, 2003). At a second glance, the present findings may shed a different perspective on the inconsistent findings in the literature: Given the reduced emotion-based processing prioritization in older adults, one could speculate whether the proposed positivity bias in older adults is actually a reduced negativity bias. Young adults showed strong processing prioritization effects of remembering more negative words in an emotion-heterogeneous context (on the expense of positive words) than in an emotion-homogeneous context. If older adults showed a similar but less strong effect, some studies could actually reveal a relative advantage of negatively-toned material over positively-toned material in young adults' memory compared with older adults' memory

in an emotion-heterogeneous list context. This alternative interpretation of a reduced negativity bias in older adults' memory would also be consistent with previous findings of studies reporting a positivity bias in older adults' memory. As it stands, this dissertation did not support the notion that older adults have a general memory bias for positive material.

#### **6.1.6 No Evidence for Differential Learning and Retention Effects for Positive, Negative, and Neutral Words**

Based on theoretical ideas in lifespan psychology (e.g., Baltes, 1987; Baltes et al., 2006) and methodological advantages, I introduced five 'study and recall' trials to the design. Moreover, to investigate differential retention for positive, negative, and neutral words, I used two different retention intervals: 1-hour and 1-week recall intervals.

In the learning phase, I found no evidence for differential learning rates for positive, negative, and neutral words. This was the case for both list conditions and for both age groups. The recall pattern was consistent across the five study and recall trials. However, it might well be that differences between age groups are only apparent at capacity limits. In this context, a testing-the-limits paradigm, in which participants are trained to the limits of their memory performance (e.g., Baltes & Kliegl, 1992; Kliegl, Smith, & Baltes, 1989, 1990), might be useful in future research. With a testing-the-limits paradigm, age-related differences in reserve potentials for remembering positive, negative, and neutral material could be examined.

Some authors have argued that emotionality can facilitate long-term storage even without selective rumination or rehearsal (Guy & Cahill, 1999; Heuer & Reisberg, 1990; Kern et al., 2002). There is also some empirical evidence for this long-term effect of emotion on memory (Kleinsmith & Kaplan, 1963, 1964). Moreover, there are theoretical ideas suggesting that memory for negative material decays faster than memory for positive material (e.g., Taylor, 1991). In contrast to these expectations, I found no evidence for differential remembering of positive, negative, and neutral words in long-term memory. Specifically, after the 1-hour and 1-week retention intervals, there was no general evidence for the proposed long-term memory enhancement effect for emotional relative to neutral material (Hypothesis 8). Only in the emotion-homogeneous list condition, neutral words were more easily forgotten than words in the positive and negative lists. There was no evidence for the proposed change in remembering positive and negative words.

### 6.1.7 Implications of the Present Findings

Three lines of research inspired the theoretical background for this dissertation: (a) lifespan theories of cognitive aging (Baltes, 1987, 1997; Baltes et al., 2006), (b) research on the interplay between emotion and memory (Christianson, 1992c; Hamann, 2001; Reisberg & Hertel, 2004), and (c) research on social cognitive aging (e.g., Hess & Blanchard-Fields, 1999). The present findings have implications for these lines of research.

The primary topic of this dissertation was based on proposals in the social cognitive aging literature that older adults' memory shows a preference for positive over negative information. This proposed positivity effect in older adults' memory is thought to be due to enhanced emotion regulation abilities in older adults (Charles et al., 2003). The findings of the present dissertation did not support this idea of a positivity effect. This was the case in both list conditions, in the learning and retention phase, and after having controlled for interindividual differences in memory- and emotion-relevant person characteristics. However, the findings of the heterogeneity-homogeneity list paradigm provided an alternative interpretation for age-related differences in remembering positive and negative information, that is, reduced emotion-based processing prioritization for negative information in older adults. This alternative interpretation shifts the focus to the negative rather than the positive material. It might be the case that older adults have specific problems in remembering negative information (as outlined above, see 6.1.5). This shift in interpretation from a positivity effect to a reduced negativity effect should influence future work in the social cognitive aging literature. Moreover, the focus on processes rather than simple outcomes in this literature might lead to a better understanding of the interactions between age, memory, and emotion.

In this context, the heterogeneity-homogeneity list paradigm has revealed its value in disentangling different explanations for differences in remembering positive and negative material. This paradigm and the associated context effect are especially relevant for general research on the interplay between emotion and memory. The finding of emotion-based processing prioritization for negative information sheds new light on past findings. Moreover, the heterogeneity-homogeneity list paradigm might be useful in other experimental contexts. For example, research on the temporal activation of the cortex (i.e., EEG) might reveal the temporal resolution of emotion-based processing prioritization.

The findings of the present dissertation are also relevant for lifespan research in general. It continues the research trend to focus more on processes rather than simple behavioral outcomes. This is especially relevant in aging-oriented research. A similar

behavioral outcome in young and older adults can be the result from quite different processes. In an extensive theory-guided research program, Margret Baltes, Paul Baltes, and their colleagues (Baltes & Baltes, 1990; Freund & Baltes, 1998, 2002; Krampe & Baltes, 2003; Marsiske, Lang, Baltes, & Baltes, 1995) have developed an overall model of lifespan development, *selective optimization with compensation* (SOC). One component of this model, compensation, is specifically related to processes or strategies that are concerned with the maintenance of functioning in response to the loss of goal-relevant means, strategies, or processes. Compensatory processes might be also evident in memory for emotional material. For example, Labouvie-Vief and colleagues (Labouvie-Vief & Medler, 2002; Labouvie-Vief & Marquez, 2004) propose that the positivity effect is a compensatory effect due to more simplified emotion schemas in older adults. Whether this is true or not is a question for future research in lifespan psychology. However, it highlights the importance to investigate processes in aging-oriented research. The present study was an attempt to investigate such processes, namely processing prioritization, by means of the heterogeneity-homogeneity list paradigm.

## **6.2 METHODOLOGICAL CAVEATS**

### **6.2.1 The To-Be-Remembered Material**

In the experimental investigation of memory and emotion, the to-be-remembered material is an important and critical factor. This factor has often been neglected in past research on the positivity effect. In the present dissertation, I attempted a careful selection of the to-be-remembered words in a separate rating study (see Chapter 4). In the Word Rating Study, 200 adjectives were rated on valence, arousal, control, imagery, self-relevance, and age-relevance. Based on these ratings, the final item pool of 30 negative, 30 positive, and 30 neutral adjectives were selected. The negative, positive, and neutral words were matched on word frequency, word length, imagery, and age-relevance. Positive and negative pictures were also matched on emotional intensity, that is, the absolute deviation from the midpoint of the valence scale.

Despite the careful selection of the to-be-remembered material, the final item pool of negative, positive, and neutral adjectives differed on some word characteristics. In particular, negative words revealed higher ratings of arousal than neutral and positive words. Given the obtained ratings for the 200 adjectives (see Chapter 4), it was not possible to select an item pool of negative, positive, and neutral words that was matched on arousal. This difference in

arousal values is relevant in light of past research of arousal and memory. There is some evidence that the level of arousal may underlie the enhancement effect for emotionally-toned material (e.g., Bradley et al., 1991; see section 2.3.2 *Arousal*). If arousal triggers the enhancement of memory by emotion, it is possible that participants in the heterogeneous list condition recalled more negative words because the negative words were more arousing than the neutral and the positive words. However, in the item-specific analyses, I did not find evidence for an effect of the level of arousal on memorability of the words. Although arousal ratings are commonly used in emotion research, the nature of arousal in these studies has remained ambiguous. Numerous studies have demonstrated that arousal is not a unidimensional construct (e.g., Matthews, Jones, & Chamberlain, 1990, Schimmack & Grob, 2000; Schimmack & Reisenzein, 2002). For example, the subjective arousal rating in the present dissertation might reflect more cognitive arousal and states of alertness than emotional arousal and agitation. Future research needs to examine the relation between different indicators of arousal (e.g., subjective and physiological).

Differences between word material and other kinds of to-be-remembered material are maybe due to differences in *semantic relatedness* between emotional and neutral words (Maratos et al., 2000; Phelps, et al., 1998; Talmi & Moscovitch, 2004). According to this idea, emotional words are better remembered than neutral words because they tend to belong to similar categories that are semantically related. Thus, emotionally-toned words share stronger inter-item associations than neutral words.<sup>26</sup> This idea is consistent with previous findings that emotionally-toned words are better remembered than neutral words in studies using emotion-heterogeneous lists of emotional and neutral words (e.g., D'Argembeau & Van der Linden, 2004; Kensinger et al., 2002). In the present dissertation, however, words were presented in both emotion-heterogeneous and emotion-homogeneous list contexts. If it is true that memory for emotionally-toned words is enhanced due to differences in semantic relatedness, the enhancement of memory by emotion should be even larger in emotion-homogeneous lists that provide ample opportunities for inter-item associations. The findings of the present experiment, however, are not totally consistent with this idea. On one hand, the analyses on the level of word sets revealed that positive words were better remembered in an emotion-homogeneous than emotion-heterogeneous condition. On the other hand, negative

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<sup>26</sup> Other kinds of material are thought to be less prone to differences in semantic relatedness between emotional and neutral categories (e.g., D'Argembeau & Van der Linden, 2004). An empirical verification of this idea that semantic relatedness depends on the kind of material is not available (and probably not possible).



words were less well remembered in an emotion-homogeneous than emotion-heterogeneous context.

### **6.2.2 Different Presentation Times for Young and Older Adults**

One might wonder whether the pattern of findings in the present dissertation was due to the different presentation times for young and older adults in the memory task. To facilitate the comparison between young and older adults in remembering positive, negative, and neutral words (i.e., Age x Valence interaction), the variation of the presentation times was an attempt to equate young and older adults in their recall performance.

I cannot rule out the possibility that the different presentation times modulated the present findings; however, the major finding - no positivity effect in older adults' memory - might be less affected by different presentation times. First, there is no reason to assume that the proposed positivity effect for older adults operates only at well-defined presentation times. Second, despite longer presentation times for older adults, older adults recalled fewer words in the learning phase than young adults did. Thus, one could actually argue that the presentation times for older adults were not sufficiently long to equate young and older adults in their recall performance.

Moreover, identical presentation times for young and older adults might give rise to different methodological problems. On the one hand, equal presentation times for both age groups would make the free recall task more demanding for older adults or less demanding for young adults. Thus, given age-related differences in cognitive resources, young and older adults might use different memory strategies under these extreme conditions. On the other hand, and more problematic for the present study, identical presentation times for young and older adults would increase the likelihood of floor and ceiling effects in the recall data. In the design of the present experiment, longer presentation times for young adults would very likely result in ceiling effects in the learning phase whereas older adults would show floor effects in the retention phase with shorter presentation times.

Put together, it is possible that the different presentation times for young and older adults might have influenced the findings of this dissertation. Additional work manipulating presentation time and list length is needed to determine the specific effects of these parameters for differential processing prioritization of emotionally-toned material in young and older adults.

### 6.3 DIRECTIONS FOR FUTURE RESEARCH

Future research on the interplay between emotion and memory processes across the lifespan will profit from methodological and conceptual advancements. These advancements might be realized by the systematic variation of (a) the type of to-be-remembered material, (b) the emotional tone of the to-be-remembered material, and (c) the memory task. In addition, the investigation of the whole lifespan might give new insights in the processes involved in the development of memory and emotion interactions across the lifespan.

#### 6.3.1 Variation of the Type of To-Be-Remembered Material

Laney, Heuer and Reisberg (2003) distinguish between visually-induced and thematically-induced emotions. *Thematically-induced* emotions are induced by involvement and empathy with an unfolding event that are pertinent to our lives, goals, and values or to the life of people we care about (e.g., film clips). *Visually-induced* emotions are induced by a visual cue such as a burned person or a happy couple (e.g., pictures). For the everyday emotions of undergraduate students, these two kinds of material revealed different experiential qualities and different natural frequencies. In comparing the natural occurrence of thematically- and visually-induced emotions, Laney and colleagues found that approximately 80% of the experienced emotions were thematically-induced and 20% were visually-induced emotions. Thus, most of our everyday emotional life is not related to a specific visual stimulus (e.g., snake) but rather to goals, values, and motivational states of the self and of close other persons (Reisberg & Heuer, 2003). This finding emphasizes the need for a systematic investigation of the type of carrier (e.g., words, pictures, films) that transports the emotional information.

In the present dissertation, I used words as to-be-remembered material, specifically adjectives. Words induce emotions by their semantic meaning rather than their visual or thematic qualities. Thus, I would like to add semantically-induced emotions to the list of Laney and colleagues (2003). *Semantically-induced* emotions are induced by the semantic meaning of the material and not by its visual features (e.g., words). Moreover, words are typically part of thematically unfolding events but one word is normally not sufficient to describe an event. Words are simple carries of information; they are often components of an emotional event.

The three types of emotion-eliciting material (i.e., semantic, visual, and thematic) differ in the degree in which they provide contextual cues. Semantic material gives essentially no contextual cues; visual material provides some information; and thematic

material presents a high degree of contextual cues. For example, the word ‘sad’ in itself gives no further information. It is the abstract meaning of the word that is transported. An image, in contrast, gives more contextual cues. The picture of a crying man in front of a grave elicits different associations than a picture of a crying man with a gold medale around his neck. These contextual cues can change the emotional information tremendously.

The three types of emotion-eliciting material may also differ in the ease of processing. In contrast to other material, words have been encountered thousands of times by every person. Their semantic meaning may be directly accessible for the individual. Other material (i.e., visual, thematic) may require more processing resources to extract the affective meaning. These “extra” processes are consequentially more prone to interindividual and intraindividual variability with regards to the affective meaning of the material. Thus, evidence for differential processing prioritization of emotional and neutral material is probably more reliably observable with semantic emotion-eliciting material. Consistent with this idea, some studies investigating attention processes have reported stronger effects for word than for pictorial material (Kindt & Brosschot, 1999; Lavy & Van den Hout, 1993; but see Kindt & Brosschot, 1997).

Thus, future research should make use of various kinds of to-be-remembered material to systematically investigate the processes involved in memory for emotionally-toned material in general and to resolve questions of a positivity effect in older adults’ memory specifically. In particular, the investigation of memory processes in more naturalistic environments might be fruitful for the study of emotions.

### **6.3.2 Variation of the Emotional Tone of the To-be-remembered Material**

Theoretical models of emotions can be described either as dimensional or as categorical (e.g., Scherer, 2000). The dimensional approach sees emotions as being distributed continuously over relatively broad dimensions. One of the pioneers of the dimensional approach was Wilhelm Wundt (1874/1905), who formulated the first explicit dimensional model. Since this first attempt, several studies consistently found two bipolar dimensions of affect. These dimensions were often labeled as pleasantness versus unpleasantness and high versus low arousal (e.g., Larsen & Diener, 1992; Russel, 1980).

On the other hand, the categorical approach sees emotions as discrete and highlights the differences between specific emotions. It views emotions as having evolved to deal with fundamental life tasks. In other words, the categorical approach stresses the role of evolution in determining the function and current display of emotion (e.g., Ekman, 1992; Levenson,

1994). In the categorical approach, the basic emotions (e.g., sadness, anger, fear, happiness) are associated with certain physiological, facial, neural, and hormonal patterns.

Past research on the interplay between memory and emotion as well as the present dissertation focused on dimensional models of emotions. Thus, the differentiation in these studies was between neutral and emotional material or between neutral, positive, and negative material. From the perspective of a categorical approach to emotion, these valence categories are too coarse to illuminate the functional role of emotions in processing information. For example, anxiety, anger, and sadness would be categorized as negative emotions in a dimensional approach. But in a categorical approach to emotions, anxiety, anger, and sadness fulfill quite different functional roles in coping with internal and external stimuli, resources and demands. It might well be that anxiety, anger, and sadness have an effect on the processing of affective material. In this respect, future research might profit from the investigation of discrete emotions and their influence on memory processes.

### **6.3.3 Variation of the Memory Tasks**

In the present dissertation, I used a free recall task. There is some evidence that the enhancement of memory by emotion is stronger in a free recall task than in a recognition task (e.g., Doerksen & Shimamura, 2001; Maratos et al., 2000). This would be consistent with contextual support approaches suggesting that the degree of environmental support influences memory performance (e.g., Craik, 1986, 2002). A free recall task provides minimal external context to guide retrieval and demands self-initiated retrieval processes. These retrieval processes most likely favor emotionally-toned material rather than neutral material. In contrast, a recognition task provides external cues to guide retrieval and therefore reduces the need for self-initiated retrieval processes. Under such conditions, memory differences for emotional and neutral material are may be reduced. The empirical evidence for these ideas on the influence of tasks is, though, rather limited. No study has systematically compared memory performance in a free recall and recognition task for the same set of to-be-remembered material. It is very likely that other factors (e.g., familiarity) may account for differential pattern in a free recall and recognition task. Thus, future research should try to investigate the influence of the type of memory task on the enhancement of memory by emotions.

Moreover, there are other memory paradigms that might be useful in conjunction with the heterogeneity-homogeneity list paradigm. For example, the overt rehearsal paradigm (Ward & Maylor, 2005) might clarify the role of rehearsal processes involved in the

heterogeneity-homogeneity list paradigm. In this paradigm, participants are asked to rehearse the to-be-remembered material aloud during the presentation of the material.<sup>27</sup> By investigating the rehearsal sequence, one might gain new insights into the differential memory pattern for the heterogeneity and homogeneity lists. This and similar combinations of paradigms might be useful to advance research that focuses on processes rather than simple outcomes.

#### 6.3.4 Memory for Emotionally-toned Material across the Lifespan

In this dissertation project, the focus was on young and late adulthood. More precisely, this dissertation project was aiming for a systematic investigation of whether older adults display a memory bias for positively-toned material or not. In contrast to recent proposals, I found no evidence for a positivity effect in older adults' compared with young adults' memory. The findings support the idea of emotion-based processing prioritization for negative information. This prioritization was stronger in young than in older adults. The interesting question for lifespan developmental psychology is how does the processing of affective material develop over the whole lifespan.

From a lifespan perspective, the measurement of only two age groups at one point in time cannot inform about age-related trajectories or age-related changes. For example, it might be that the enhancement of memory by emotion follows a U-shaped function with a peak in middle adulthood and a minimum in childhood and very old age (> 85 years). This and similar patterns across the lifespan are not visible with a cross-sectional design of two age groups.

Although no study investigated the whole lifespan, there is some empirical evidence that emotional material and specifically negative material is already prioritized in young children. Tindall and Ratcliff (1974) found, for example, that children (6, 10, and 14 years) performed significantly better in a punishment than in a reward condition. Children's age did not influence the effect suggesting that negative information is already prioritized in 6- to 7-year-old children.

At the end of the lifespan, however, emotion-based processing prioritization might be less robust. For example, Wright and colleagues (1998) found that memory clarity for the

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<sup>27</sup> For example, participants are presented with the following word sequence: amused – angry – strong – naïve – fearful... One participant might have the following rehearsal sequence for the presented sequence: **amused** - amused - amused - **angry** - angry - amused - **strong** - strong - amused - **naïve** - angry - naïve - **fearful** - amused - strong ... The words in bold are presented on the screen and read aloud by the participant. The words inbetween are rehearsed by the participant.

resignation of Margaret Thatcher as prime minister and the Hillsborough stadium disaster decreased after the age of 75 years. However, the decline in memory clarity for these naturally-occurring emotional events can also be due to a general decline in memory performance rather than a specific decline in memory for emotionally-toned material. Consistent with this interpretation, studies with Alzheimer disease patients revealed that even demented patients remember emotionally-toned events better than neutral events (e.g., Budson et al., 2004; Ikeda et al., 1998; Kazui et al., 2000; Mori et al., 1999).

The study of emotion-cognition interaction would benefit from the investigation of the whole lifespan to examine age-related trajectories. Moreover, the present dissertation with its cross-sectional design cannot rule out the possibility of cohort effects that might influence the effect of emotion on memory processes. In this context, future research should focus more on the possibility to examine memory for emotionally-toned material in a longitudinal design.

#### **6.4 CONCLUSIONS**

The pattern of findings in this dissertation project did not provide empirical support for recent suggestions of a positivity effect in older adults' memory. There was no evidence that older adults prioritize positive information over negative information and more so than young adults. This was the case in both list conditions and in the learning and retention phase. In general, the memory pattern for positive, negative, and neutral words was similar for both age groups.

Consistent with the general idea that negative information affords more processing resources (e.g., Pratto & John, 1991), I found a memory advantage for negative words over positive and neutral words in the emotion-heterogeneous list condition but not in the emotion-homogeneous list condition. This finding supports the idea of a general negativity bias in memory. People are not hardwired to attend to the negative aspects of their lives. But if stimuli from different valence categories are in competition with each other, the findings suggest that negative information is prioritized.

Emotion-based processing prioritization for negative information was diminished in older adults' memory. This finding might be due to a reduced capacity in older adults to discriminate affective information. However, future research should focus on potential mechanisms and theoretical accounts for age-related differences in processing prioritization. As it stands, the findings of the present dissertation did not support the idea that older adults remember positive information better than negative ones and more so than young adults.