

## CHAPTER 1: INTRODUCTION

Human memory is selective. We tend to remember some of our experiences better than others. Many people perceive this as a problem and would like to enhance their memory. This is true not only for specific populations with memory disorders (e.g., Alzheimer's disease, dementia) but also for healthy adults. And the benefits of memory enhancement are obvious: We would not forget names, receipts, or keys anymore. But there are as well costs: We would store millions of useless facts, conversations, and news. Thus, there are some things that do not need to be recalled and others that bestow substantial meaning to the life of the individual: the first kiss, the day of your marriage, or the death of your grandparents. "Thus, what we need is *selectively* enhanced memories of our *significant* experiences" (McGaugh, 2003, p. 59; italics in original). As I will outline in the introduction, we are already equipped with a memory system that selectively remembers significant experiences. And this seems to be the case across the lifespan. In particular, our memory system strengthens memories for *emotionally-charged* events.

The major topic of this dissertation project is memory for emotionally-toned material and is inspired by three lines of research: The first is derived from lifespan developmental theories (Baltes, 1987, 1997; Baltes, Lindenberger, & Staudinger, 2006). The theoretical assumptions of lifespan developmental psychology build the core framework for the present dissertation. The second line of research is derived from the longstanding interest in the interplay between emotion and memory. Many studies show that individuals typically remember emotionally-toned stimuli better than neutral stimuli (for reviews see Christianson, 1992c; Hamann, 2001; Reisberg & Hertel, 2004). It is not known, however, whether humans are attuned to process emotional information per se or whether there is a difference in the processing of negative and positive information in memory. The third line stems from a rapidly growing literature on social cognitive aging (e.g., Hess & Blanchard-Fields, 1999). In this line of research, some authors suggest that older adults remember positive information better than negative information and more so than young adults (e.g., Charles, Mather, & Carstensen, 2003). The empirical evidence for this proposed positivity effect in older adults memory is, however, inconsistent.

In this dissertation project, questions about a positivity effect in older adults' memory are considered in the context of research regarding the general role of emotions in memory. Chapter 1 gives a general overview of research about the operation of emotion in memory. This overview leads directly to the main research question of this dissertation project: *Are*

*there age-related differences in remembering emotionally-toned material?* Specifically, do older adults prioritize positive information over negative information in memory? These research questions are considered in Chapter 2, which provides a thorough literature review of empirical studies that compare young and older adults' memory for emotionally-toned material. In addition, proposed mechanisms involved in the enhancement of memory by emotion are discussed with regard to potential age-related differences in these mechanisms. The specific research hypotheses and research design are outlined in Chapter 3. To select adequate to-be-remembered word material for the central experiment, a preparatory study was conducted (Chapter 4). The main experiment, in which young and older adults were asked to recall positive, negative, and neutral words under two conditions that differentially afford processing prioritization, is considered in Chapter 5. This dissertation project aimed, on the one hand, to systematically explore age-related differences in the positive-negative disparity of emotional memory. On the other hand, it investigated the idea of emotion-based processing prioritization for negatively-toned material in young and older adults.

## **1.1 LIFESPAN PERSPECTIVES ON THE AGING MIND**

### **1.1.1 The Bio-cultural Orchestration of the Aging Mind**

One cornerstone of developmental lifespan psychology deals with the interplay of the biological and cultural architecture of human development (Baltes, 1997; Baltes et al., 2006; Baltes & Smith, 2004; Li, 2003). Questions in this context are: What is the role of biological (genetic) and cultural (environmental) factors in human ontogenesis? How do they interact, modify, and constrain each other? The main insight from this perspective is that the overall architecture of human development is incomplete (Baltes, 1997): The architecture of human development continues to evolve in a biological and cultural co-evolution and co-construction (Baltes, Reuter-Lorenz, & Rosler, 2006). A second insight is that old age is the most undeveloped age period in the gene-environment interplay. While the early years of the life course can profit from a long tradition in the biological and cultural co-evolution and co-construction, the biological and cultural co-construction for later years of the life course are relatively “young”.

Based on the overall biocultural landscape of human development, human aging is conceptualized as a joint combination of gains and losses (Baltes, 1993; Baltes et al., 2006). This conception of human aging is characterized by a differentiated and multidirectional view (rather than by a unidimensional decline) that also includes the potential for positive signs of

old age. Consistent with this conceptualization, a core assumption of developmental lifespan psychology is that development is not completed at adulthood. Instead, development is a lifelong process involving adaptive changes across the entire life course (Baltes, 1987, 1997; Baltes & Goulet, 1970; Neugarten, 1969; J. Smith & Baltes, 1999; Staudinger & Lindenberger, 2003; Thomae, 1979). By moving through life, one can distinguish three functions of ontogenetic development: growth, maintenance, and regulation of losses (Baltes, 1987; Brandtstädter & Greve, 1994; Heckhausen & Schulz, 1993; Staudinger, Marsiske, & Baltes, 1995). With *growth*, behaviors are portrayed that aimed at achieving higher levels of functioning. *Maintenance* (resiliency) comprises behaviors that focus on maintaining levels of functioning in the face of challenges or on returning to previously reached levels of functioning after a loss. With the *regulation of loss*, behaviors are covered organizing functioning at lower levels of functioning after losses. Theorists of lifespan psychology have suggested that the allocation of available resources for these three functions of ontogenetic development changes across the life course (Baltes, 1987; Staudinger et al., 1995). In childhood and early adulthood, resources are primarily directed to growth behaviors. During adulthood, the maintenance (and recovery) of level of functioning receives more and more resources. In old and very old age, resources are increasingly allocated to the regulation of loss. Thus, less and less resources remain available to be allocated to growth behaviors in old age.

To integrate the functions of development (i.e., growth, maintenance, regulation of losses; Baltes, 1987), the model of selection, optimization, and compensation (SOC; Baltes & Baltes, 1990; Freund & Baltes, 2000) offers a process model of human development. Based on the notion of an increasingly less positive ratio of developmental gains to losses in adulthood (Baltes, 1987; Baltes et al., 2006), the SOC model proposes general mechanisms that allow individuals to successfully maximize gains (growth) and minimize losses. Specifically, growth-related processes include the selection, commitment to, and pursuit of goals by acquiring and refining goal-relevant means (elective selection; optimization). In face of declining resources, functions can be maintained and losses can be minimized by using compensatory strategies of goal-attainment or by selecting new goals (compensation; loss-based selection). The differentiation of growth and prevention of loss (or maintenance of functioning) is related to the idea of approach (attainment of positive outcomes) versus avoidance motivation (avoidance of negative outcomes; Ebner, Freund, & Baltes, in press; Elliot & Covington, 2001).

The model of SOC provides a general framework for human development that is applicable to a large range of variations in goals and means of development. SOC is relativistic because it can be applied to any variation of motivational, social, and intellectual resources as well as to different criteria to define successful development. But the model of SOC is also universal because it is argued that any process of development involves components of selection, optimization, and compensation (Baltes & Baltes, 1990; Marsiske, Lang, Baltes, & Baltes, 1995).

### **1.1.2 Lifespan Perspectives on Memory**

There is much evidence in the cognitive aging literature that memory functioning declines with age (for reviews, see Bäckman, Small, & Wahlin, 2001; Light, 1996; Smith, A. D., 1996; Zacks, Hasher, & Li, 2000). This decline is evident across different types of to-be-remembered material: Older adults, for example, perform less well than younger adults in memory tasks for lists of words (e.g., A. D. Smith, 1977), texts (e.g., Dixon, Simon, Nowak, & Hulstsch, 1982), faces (e.g., Bartlett, Zhao, Desmond, Glover, & Gabrieli, 1989), contextual details (e.g., Park & Puglisi, 1985) and television news (e.g., Frieske & Park, 1999). Moreover, age-related declines are also apparent across different domains of memory functioning. Age-related differences have been revealed in tests of episodic memory (e.g., Nilsson et al., 1997; Salthouse, 1998), semantic memory (e.g., Hulstsch, Hertzog, Small, McDonald-Miszczak, & Dixon, 1992), working memory (e.g., Salthouse, 1991; Salthouse & Babcock, 1991), procedural memory (e.g., Hashtroudi, Chrosniak, & Schwartz, 1991), and different forms of priming (e.g., LaVoie & Light, 1994). Despite this enormous evidence for age-related differences in memory functioning, several empirical studies have revealed that age-related change is not entirely uniform across domains of memory functioning (e.g., Park et al., 1996, 2002). For example, age-related decline is small or not evident for picture recognition (e.g., Park, 1998; A. D. Smith, Park, Cherry, & Berkovsky, 1990), semantic memory, and some sorts of priming (for reviews, see Bäckman et al., 2001; Light, 1996; A. D., Smith, 1996; Zacks et al., 2000).

Despite the general fact that memory performance declines with age, older individuals can enhance their intellectual abilities by practice and/or training, that is, they show intraindividual plasticity in memory performance (e.g., Baltes, Kliegl, & Dittmann-Kohli, 1988; Baltes & Lindenberger, 1988; Baltes & Willis, 1982; Verhaeghen, Marcoen, & Goosens, 1992). These positive training effects have, however, their limits. There are age-related losses in plasticity and performance potentials. In an extensive, theory-guided training

program, Baltes, Kliegl, and Smith used a testing-the-limits procedure to investigate age-related differences in reserve potentials in memory performance. In one set of studies (Baltes & Kliegl, 1992; Kliegl, Smith, & Baltes, 1989, 1990), young and older adults were trained in a mnemonic technique (i.e., Method of Loci). Instructions in the mnemonic technique substantially improved the memory performance of both young and older adults. Despite the enhancement of memory by acquiring the mnemonic technique, the highest functioning older adults were still below the mean performance of the young adults. A more recent investigation has shown that reserve potentials are even more reduced in very old age (T. Singer, Lindenberger, & Baltes, 2003). These findings suggest that training and practice can tremendously enhance the memory performance of older adults. However, there are age-related limits in reserve capacities and intraindividual plasticity.

Dominant views of causes of age-related declines in memory function are varied in the cognitive aging literature. One set of theories is related to the common idea of a decline in processing resources that limit the ability to encode and retrieve information (e.g., Baltes & Lindenberger, 1997; Lindenberger & Baltes, 1994; Salthouse, 1994, 1996). One of the earliest records of this theory was presented by Craik and Byrd (1982). They argued that observed age-related declines in memory were caused by decreased “mental energy” or processing resources that limited the ability of older adults to engage in self-initiated processing. Later theorists have suggested that empirical measurement of processing resource could be represented by speed of information processing or working memory capacity. The empirical evidence has conclusively demonstrated that both speed of processing and working memory mediate most, if not all, age-related variance in long-term memory (e.g., Park et al., 1996, 2002; Salthouse, 1994, 1996; Salthouse, Mitchell, Skovronek, & Babcock, 1989; Salthouse & Babcock, 1991). In contrast to resource-based theories of age-related decline in memory functioning, inhibition theory suggests that older adults are less effective at gating and selecting information (Hasher & Zacks, 1988; Zacks & Hasher, 1997). Hence, they have less capacity available for effective encoding and retrieval of material, resulting in long-term memory deficits. Other views of age-related decline in memory functioning include poor source memory for which decreased ability to remember the context or source in which information is presented limits accurate recall of material in old age (Johnson, Hashtroudi, & Lindsay, 1993).

### 1.1.3 Social-cognitive perspectives on Aging, Memory, and Emotion

There is a growing body of research on social cognitive aging focusing on the operation of cognition in social-emotional contexts (e.g., Hess & Blanchard-Fields, 1999). In this line of research, the content of information processing plays an important role. Thus, unlike mainstream cognitive research, it becomes impossible to ignore how factors such as the social-emotional context and social-emotional knowledge influence information processing. In social-cognitive aging research, the question is then whether there are age-related differences in the interaction between the social-emotional context and memory functioning.

Despite the lifespan shift in the relative allocation of resources to the functions of growth, maintenance, and regulation of loss (Baltes et al., 2006), some domains of functioning can show positive outcomes in advanced age: One of these domains might be emotional functioning (Carstensen, 1995; Carstensen, Isaacowitz, & Charles, 1999; Staudinger, Freund, Linden, & Maas, 1999). In stark contrast to cognitive aging, several lifespan theories of emotion have suggested that emotional competencies are maintained or even improved during adulthood and old age (e.g., Blanchard-Fields, 1998; Carstensen, 1995; Labouvie-Vief, 1998). Indeed, there is a growing body of empirical evidence supporting these ideas. Older adults, for example, have the capacity to experience complex feelings in everyday life (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000), are able to up- and down-regulate emotional reactions voluntarily (e.g., Kunzmann, Kupperbusch, & Levenson, 2005), have the capacity to elicit strong emotional reactions (e.g., Kunzmann & Grühn, 2005), have a deep emotional understanding (e.g., Labouvie-Vief, 1998), and utilize emotions constructively in everyday problem solving (e.g., Blanchard-Fields, 1998). Thus, despite losses in the domains of cognitive functioning and health, older adults seem to maintain a high level of functioning in the domain of emotion.

In addition, some authors argue that the ability to regulate emotions increases with age (Carstensen et al., 1999). In this context, emotion regulation is defined as maximizing positive affect and minimizing negative affect. This age-related increase in emotion regulation abilities is thought to be related to two aspects: First, an accumulation of experience and knowledge in the regulation of loss in general and emotion in particular might cultivate the ability to cope with emotions in advanced age. Second, changes in the time horizon (i.e., the time left in life) might alter the focus to more emotional meaningful aspects of life in older adults. This change in focus might also promote the ability to regulate one's emotions. In this context, recent work in the social-cognitive aging literature (e.g., Hess &

Blanchard-Fiels, 1999) suggest that memory for emotionally-toned material might be one domain of functioning that show a more positive profile in old age than in young adulthood (e.g., Carstensen & Mikels, 2005; Carstensen & Turk-Charles, 1994). Thus, some authors argue that older adults focus more on positive and less on negative information. This shift in motivational focus is thought to influence the memory system in such a way that older adults remember more positive than negative information relative to young adults (Charles et al., 2003). This proposed positive profile for emotional memory in old age is in stark contrast to the general age-related decline in memory functioning.

The motivational shift to more emotional meaningful aspects in the life of older adults (Carstensen, 1995; Carstensen et al., 1999) is also consistent with proposals derived from the model of SOC (Baltes & Baltes, 1990). The model implies that older adults can adaptively respond to negative age-related changes by placing a focus on strategies of compensation and loss-based selection. In line with this theoretical argument, Ebner, Freund and Baltes (in press) empirically showed that younger adults primarily orient their goals towards growth (i.e., approach), whereas older adults primarily focus on maintenance and prevention of loss (i.e., avoidance; see also Heckhausen, 1997). In addition, adopting a maintenance and prevention of loss focus was positively related to older adults' subjective well-being, whereas adopting a growth focus was positively related to younger adults' subjective well-being (Ebner et al., 2006). These theoretical ideas and empirical findings might suggest that older adults tend to avoid negative states and motivational orientation (i.e., losses). If older adults show a stronger avoidance motivation, this might be translated into basic cognitive processes such as attention and memory.

From a conceptual perspective, the plasticities of memory and emotional functioning show diverging trajectories of development. On the one hand, memory functioning declines with age. On the other hand, emotional functioning seems to be maintained or even improved with age (e.g., Carstensen et al., 1999; Labouvie-Vief, DeVoe, & Bulka, 1989, Mather, 2003). These diverging trajectories are evidence for the multidimensional and multidirectional structure of human development (Baltes, 1987; 1997; Baltes, Lindenberger, & Staudinger, 1998). In an overall architecture of lifespan development, this pattern is consistent with the changing dynamics between biology and culture across the lifespan (Baltes, 1993, 1997; Baltes et al., 2006). On the one hand, there is an age-related decline in biological functioning; on the other side, the accumulation of experience and knowledge across the life course might compensate for biological losses. In this view, individuals might invest more and more resources in regulating and compensating for age-related deficits in

biological functioning. In so doing, new bodies of knowledge, behaviors and values are generated that provide higher levels of adaptive capacity than solely given by biology. In this overarching framework of lifespan development, memory for emotionally-toned material might reveal a dynamic interplay between the biology-based *mechanics* and the culture-based *pragmatics of life* (Baltes et al., 2006). The mechanics reflect organizational properties of the neurophysiological architecture of the brain as evolved during biological evolution. The pragmatics, in contrast, are associated with experience-based bodies of knowledge acquired from and mediated through culture.

Memory for emotionally-toned material is located at the intersection of the biology-culture and mechanics-pragmatics distinctions. Memory performance is primarily related to the biology-based mechanics whereas the semantic meaning of the emotional information and the ability to regulate emotions are primarily associated with experience-based bodies of knowledge (i.e., strategies), that is, the pragmatics of life. Clearly, memory and emotional knowledge cannot be entirely assigned to represent either mechanics or pragmatics, but rather their relative location between the mechanics and pragmatics can be specified. From a theoretical perspective, the investigation of a research area that depends on two or more interacting components that reveal diverging lifespan trajectories may be of special interest for aging-oriented research. It might well be that such an area provides the opportunity to investigate age-related processes from a complementary, co-constructive perspective. The field of emotional memory might be such an area. For example, based on a general lifespan developmental script about the relative allocation of resources (Baltes, 1997; Baltes et al., 2006), more resources might be allocated to emotional functioning (e.g., emotion regulation) to compensate for declines in cognitive functioning (e.g., memory) as people grow older.

## 1.2 MEMORY FOR EMOTIONALLY-TONED MATERIAL

Functional emotion theories have emphasized the adaptive value of emotions (e.g., Campos, Campos, & Barrett, 1989; Ekman, 1999; Frijda, 1986; Izard, 1993; Keltner & Gross, 1999; Levenson, 1994). According to these theories, emotions communicate important information to one's self and others, and they help motivate and coordinate one's own and other's behaviors. Some emotions serve to push us away from certain thoughts, memories, or actions, whereas other emotions facilitate certain thoughts, memories, or actions. Indeed, various authors suggest that the adaptive function of emotion could be to selectively guide or determine different modes of information processing (e.g., Gray, 1999, 2001; Tomarken &



Keener, 1998; Tucker & Williams, 1984). Emotion could transiently enhance or impair some processes but not others, doing so relatively, rapidly, and flexibly. Thus, by changing processing priority of some information, emotion could adaptively bias the overall control of behavior to meet situation-specific demands. For example, positive affect may promote cognitive flexibility and creativity (see Fredrickson, 1998; Isen, 1987, 1993) whereas negative affect may lead people to more analytic thinking (e.g., Fiedler, 1988). Moreover, negative affect could bias people to prioritize immediate gains, despite long-term costs (Gray, 1999).

One influence of emotion on cognitive processes has long been known, namely the *enhancement of memory by emotion*. Many studies show that individuals typically remember emotionally-toned material better than neutral material (for reviews see Christianson, 1992b; Hamann, 2001; Reisberg & Hertel, 2004). This literature on the enhancement of memory by emotion can be broadly divided in two major branches: naturalistic and experimental approaches. Research in the tradition of naturalistic approaches uses naturally-occurring events, whose tremendous social and political impact are experienced by many people, for example, the assassination of President Kennedy. This line of research has no control about the nature of to-be-remembered events; however, these events are highly emotional and ecologically valid. On the other hand, research in the tradition of controlled laboratory experiments uses systematically manipulated to-be-remembered material. This line of research has full control about the to-be-remembered material; however, the emotional intensity of the material as well as the ecological validity is typically low.

### **1.2.1 Naturalistic Approaches to the Investigation of Emotional Memory**

William James believed that “an impression may be so exciting emotionally as almost to leave a *scar* upon the cerebral tissues” (1890, p. 670; italics in original). An extreme example of this enhancement of memory by emotion is the so-called *flashbulb memory hypothesis*: a highly vivid memory for an intensely emotionally engaging event such as hearing the news about the assassination of President Kennedy, the collapse of the World Trade Center, or the deadly Tsunami in South-East Asia. The flashbulb memory hypothesis states that highly unexpected and highly relevant events imprint a vivid record of the event and the circumstances on an individual’s memory (R. Brown & Kulik, 1977). This imprint is like a photo of the current contents of consciousness. For example, people could typically not only remember that the World Trade Center collapsed on September 11, 2001, but they could also remember with perceptual clarity, where they were when they heard the news, who was

with them, who told them, and what they were doing at the time, etc. Support for the flashbulb memory hypothesis has been found in numerous studies investigating naturally-occurring consequential events for the political and social life (Conway, 1995; Finkenauer et al., 1998; Winograd & Neisser, 1992). Other examples for such events are the assassinations of John F. Kennedy and Martin Luther King (R. Brown & Kulik, 1977), the deaths of Princess Diana (P.S.R. Davidson & Glisky, 2002) and French President Francois Mitterand (Curci, Liminet, Finkenauer, & Gisle, 2001), the Hillsborough stadium disaster (Wright, 1993), the explosion of the space shuttle Challenger (Bohannon, 1988; Bohannon & Symons, 1992; McCloskey, Wible, & Cohen, 1988; Neisser & Harsch, 1992), the Loma Pietra earthquake (Neisser et al., 1996), the assassination attempt on Ronald Reagon (Pillemer, 1984), the resignation of British Prime Minister Margaret Thatcher (Conway et al., 1994), the verdict announcement in the O.J. Simpson trial (Schmolck, Buffalo, & Squire, 2000; Winningham, Hyman, & Dinnel, 2000), and the September 11 tragedies (Pezdek, 2002; Schmidt, 2004). Most of these studies suggest that confidence in the ability to accurately remember emotionally-charged events is remarkably high, and that these events and the contextual details associated with them are recalled with especially high accuracy.

In addition, other studies have supported the view that memories of personally relevant events also tend to be quite vivid, detailed and resistant to decay over time. Walker, Vogl, and Thompson (1997), for example, asked participants to record personal events for approximately 14 weeks in a diary. They found that rated emotionality of an event was strongly correlated with reported imagery of the event. Reisberg and colleagues (Reisberg, Heuer, McLean, & O'Shaughnessy, 1988) reported a correlation of .71 between participants' ratings of their memories' vividness and their ratings of how emotional the original event had been. Other studies confirm this pattern, observing extreme memory vividness for traumatic and extreme positive events (e.g., Berntsen, 2001; Pillemer, Goldsmith, Panter, & White, 1988; Porter & Birt, 2001; Rubin & Kozin, 1984).

Although such emotional autobiographical events are highly vivid and detailed, imagery *per se* is not a guarantee for accuracy. Vivid memories can be wrong. A first demonstration that imagery cannot be equated with accuracy came from Neisser and Harsch (1992). One day after the Challenger explosion in 1986, they interviewed 106 students about the situation in which they first heard the news. Where was it, what time was it, how did you hear it, what were you doing, who else was there? Nearly 3 years later, Neiser and Harsch reinterviewed 44 of these students. They found that the students still reported very vivid, detailed memories about the situation with high levels of confidence. A large number of the

retrospective memories, however, were simply wrong. In many reports, small differences occurred such as a different time point of hearing the news, not the sister but the mother has told the news, or seeing the news in TV instead of hearing the news in the radio. In some instances, however, completely new situations were reported (11 students recalled a completely different episode, in contrast to 3 students, who recalled the exact situation).

This dramatic loss in correct retrieval does not mean that memory for emotional events is typically inaccurate. To the contrary, emotional events are often very precise compared with neutral events, because emotional events are normally related to aspects that are important for our life. Several studies show, for example, that the intensity of the initially experienced emotion correlates with recall accuracy (Bohannon, 1988; Conway et al., 1994; Pillemer, 1984; Schmolck et al., 2000). What the loss in accuracy of event-vivid and high-confident memories serves to highlight is the constructive and reconstructive power of the memory system, in which retrieval of information depends to some degree on factors like the current mood, motivation and goals (Bartlett, 1932; Bower & Forgas, 2000; J.R. Singer & Salovey, 1993). The reconstructive power of the memory system makes it a very flexible system but also one that is prone to inaccurate reinterpretation of the past. Moreover, rehearsal and elaboration following naturalistic events are likewise difficult to control because people tend to create narrative descriptions of salient emotional events that they subsequently repeat or communicate to others, often many times in the weeks, months, and even years between encoding and memory test (see McClosky et al., 1988; Neisser & Harsch, 1992; Neisser et al., 1996; Pezdek, 2002; Pillemer, 1984; Weaver, 1993). As a result, flashbulb memory effects may reflect enhanced elaboration and repetitive encoding of emotional experiences during the recall interval, rather than the superior initial encoding that the term “flashbulb” suggests.

What can be drawn from the Neisser and Harsch (1992) data is that emotional memories can be extremely vivid, extremely compelling, and yet completely out of step with the historical facts. Their findings demand that we *test* the accuracy of emotional memories and not assume that they will be accurate on the basis of vivid recollections. This emphasizes the need for controlled laboratory studies.

### **1.2.2 Experimental Approaches to the Investigation of Emotional Memory**

Naturalistic approaches obviously provide insights into how people remember the genuinely emotional events that actually take place in their lives. The disadvantage of these studies, however, is that we often have no way of knowing exactly what happened during the

target event and thus no means of assessing the accuracy of memory. For this reason, the study of memory accuracy has often been taken into the laboratory so that we now have full knowledge of and full control over the to-be-remembered material.

Despite some preliminary experimental studies by Gordon (1904), Henderson (1911), and Tait (1913), experimental work on the affective meaning of the to-be-remembered material was initiated with the work of Frederic C. Bartlett. The publication of his book *Remembering* (Bartlett, 1932) was a turning point in memory research. Bartlett highlighted the importance of affective meaning in reproducing and organizing material in memory. He emphasized the reconstructive capacities of the memory system in making to-be-remembered material reasonable coherent to already established knowledge. A well-known example discussed in his book is that of the recollections of a North American folk tale called *The War of the Ghosts*. He could show that remembering is a creative act that accesses much more information than originally stored.

Contemporaneously to the appearance of *Remembering* (Bartlett, 1932), the number of experimental laboratory studies investigating memory for emotionally-toned material increased considerably in the 1920ies and 1930ies (e.g., Cason & Lungren, 1932; Chaney & Lauer, 1929; Flügel, 1924; Fox, 1923; Jersild, 1931; Koch, 1930; Lynch, 1932; Meltzer, 1930a, 1930b, 1931; Menzies, 1935; Silverman & Cason, 1934; Waters & Leeper, 1936; M. M. White, 1936; M. M. White & Ratcliff, 1934; Wohlgenuth, 1923). The sheer amount of experimental studies in the realm of emotion-memory interactions was supplemented with some excellent monographs in these early years (Beebe-Center, 1932; Rapaport, 1942). This stimulating rise of experimental research was abruptly terminated with the beginning of World War II. In the following decades, memory for affectively-toned material was for many years not prominent in experimental memory research. Beginning with the advance of neuroimaging techniques, a revival of experimentally-oriented studies in the domain of emotional memory occurs. This revival is due to a major interest in the neuropsychological and neuroanatomical underpinnings of memory processes for emotionally-toned material (e.g., Dolan, Lane, Chua, & Fletcher, 2000; Haman, 2001; Kosslyn, Shin, Thompson, & McNally, 1996).

In this longstanding tradition of experimentally-oriented research, the majority of studies have indeed shown that memory performance for emotionally-toned material is enhanced relative to the performance for neutral ones (for reviews see Christianson, 1992b; Hamann, 2001; Reisberg & Hertel, 2004). This enhancement effect of memory by emotion has been reported with various kinds of materials such as words (e.g., Dietrich et al., 2001;

Jones, O’Gorman, & Byrne, 1987; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002; Kleinsmith & Kaplan, 1963, 1964; Nagae & Moscovitch, 2002; Schürer-Necker, 1984), novels (e.g., Carstensen & Turk-Charles, 1994; Schürer-Necker, 1988), pictures (e.g., Bradley, Greenwald, Petry, & Lang, 1992; Canli, Zhao, Brewer, Gabrieli, & Cahill, 2000; Hamann, Ely, Frafton, & Kilts, 1999; Kensinger et al., 2002), faces (e.g., Mather & Carstensen, 2004), films (e.g., Cahill et al., 1996), humor (e.g., Schmidt & Williams, 2001), and for stories presented by a sequence of pictures (e.g., Burke, Heuer, & Reisberg, 1992; Heuer & Reisberg, 1990). This effect has also been found for different types of memory tasks (e.g., free recall, cued recall, recognition) and different retention intervals.<sup>1</sup>

There is, however, 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, Allan, & Rugg, 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 maybe 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, the idea that the degree of enhancement of memory by emotion depends on the type of task should be considered with caution.

It has also sometimes been found that the enhancement effect of emotion on memory is stronger in delayed rather than immediate retrieval (e.g., Butter, 1970; Kleinsmith & Kaplan, 1963, 1964; LaBar & Phelps, 1998; Quevedo et al., 2003). Some authors argue that the enhancement of memory by emotion is partly due to post-encoding consolidation processes that operate days and weeks after the emotional event (e.g., Cahill & McGaugh, 1996, 1998). Similar to the free recall and recognition distinction, there are only very few studies available that have actually investigated different retention intervals for the same set of to-be-remembered material under similar conditions. Moreover, most of these studies

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<sup>1</sup> The delays between encoding and retrieval vary tremendously between immediately and several months.

show floor effects in the delayed retrieval making their findings difficult to interpret (e.g., Bradley et al., 1992; Denburg, Buchanan, Tranel, & Adolphs, 2003). Again, caution is needed regarding the idea that the influence of emotion on memory depends on the retention interval.

The majority of laboratory studies that focus on memory for emotional material has considered the so-called *Easterbrook hypothesis*. Based on animal studies, Easterbrook (1959) proposed a narrowing of attention as a function of arousal. As the arousal state increases, the organism becomes more sensitive to central information of an event and less sensitive to peripheral information. Correspondingly, Christianson (1992a, 1992b) and Burke, Heuer, and Reisberg (1992; Heuer & Reisberg, 1990, 1992; Reisberg & Heuer, 2003) proposed that emotional events lead people to focus on the gist of the story. In contrast, background details that are not important for the gist receive less attention. In the eyewitness memory literature, a similar pattern known as *weapon focus effect* has often been observed (e.g., Loftus, 1979; Loftus, Loftus, & Messo, 1987; Steblay, 1992). This effect refers to the fact that victims or witnesses of a crime pay more attention to the criminal's weapon and less attention to surrounding details. This effect goes so far that victims are able to remember the weapon in great clarity, but are unable to remember crucial details of the criminal such as the hair color.

Several studies have supported this motivational view of attention narrowing. Wessel and Merckelbach (1997, 1998), for example, invited spider phobics and non-phobic control participants to the laboratory. Participants were presented with either a large, live spider or a sequence of pictures of spiders. In both cases, spider phobics were more aroused by the threat-related cues than the control group. In a subsequent memory task, spider phobics showed the expected pattern of narrowing. They showed better memory for the events' center (i.e., the spiders) and worse memory for peripheral details than control participants (see also Amir, McNally, Riemann, & Clements, 1996; Lundh, Czyzykow, & Öst, 1997; MacLeod & McLaughlin, 1995; Reidy & Richards, 1997).

It should be acknowledged, though, that not all studies confirm the Easterbrook Hypothesis. A number of studies have failed to replicate memory narrowing for emotional events (e.g., Libkuman, Nichols-Whitenead, Griffith, & Thomas, 1999; Wessel, van der Kooy, & Merckelbach, 2000). Instead, these studies often find that the emotional tone promotes (or enhances) memory for both central and peripheral details.

In addition to quantitative measures of memory (i.e., the amount of items that are recalled or recognized), the emotional meaning of an event also seems to influence the

subjective state of awareness accompanying this event. Some studies have used the “remember-know” procedure in which participants are asked to indicate whether their recognition is accompanied by a detailed sense of reexperiencing an item (in which case, a remember response would be made), or whether it simply seems familiar (in which case, a know response is made; Gardiner & Richardson-Klavehn, 2000; Tulving, 1985). It has been found that emotional words (D’Argembeau & Van der Linden, 2004; Dewhurst & Parry, 2000) and emotional pictures (Ochsner, 2000) are more likely to be remembered than neutral ones. This finding suggests that people are better able to retrieve some recollections of what happened at the time an emotional item was encoded rather than for a neutral one. Or to say it in different words, the emotional tone of an item also enhances memory for contextual information that is highly associated with the emotional item. On the first glance, these findings seem to contradict the idea of memory narrowing for central but not for peripheral details of an emotional event. However, it depends on what aspects are thought to be central or peripheral in an emotional event. In real life events, it is seldom possible to categorize details without doubt as either central or peripheral.

It is quite obvious that emotional events are different from neutral ones in many ways. Emotional events (a) are often accompanied by subjective, behavioral, and physiological changes, (b) receive closer scrutiny (i.e., attention), (c) are more likely to be rehearsed, (d) are relative distinct or unusual, and (e) are related to important themes and goals in our lives. These factors are difficult to control in any study of emotional remembering, but, even so, at least some evidence suggests that it is the *emotionality* that matters, over and above the undeniable contributions of these other points (e.g., Reisberg & Hertel, 2003). For example, the studies by Wessel and Merckelbach (1997, 1998) are very instructive in the sense that it is the *same event* that is being remembered by the aroused (phobics) and less aroused (non-phobics) participants. This allows us to set aside a range of concerns that focus on some aspects of the emotional event (e.g., familiarity, distinctiveness) other than their emotionality.

Another instructive example that it is the emotional tone that matters in the enhancement of memory comes from research on the distinctiveness of emotional events. Emotional events are usually unusual for our everyday live. If emotional events were not uncommon to some degree, the events would probably lose their emotional meaning. Some researchers (e.g., Christianson, 1992b) argue that the distinctive nature of an emotional event may facilitate memory for this event. A burned face, for example, in a series of normal faces is not only a negative picture; it is also very distinct from normal faces. Initial support for the idea that distinctiveness enhances memory for emotional events was provided by a study

about randomly sampled autobiographical events (Brewer, 1988). In this study, the uniqueness of an event was the best predictor of how well it can be recalled later on. This study has, however, little control or information about the personal events. In an experimental investigation of this question, Christianson and Loftus (1991) investigated memory performance for three types of slide stories. In a neutral version, a woman rides her bicycle; in an emotional version, a woman was injured while riding her bicycle; and in an unemotional but unusual story, a woman was carrying a bicycle on her shoulder. This experiment provided the opportunity to disentangle the influence of distinctiveness and emotionality on memory performance. The results showed that memory for the emotional version was enhanced in contrast to memory for the unusual version (see also Schmidt, 2002). Thus, the finding of this study supports the view that it is the emotional tone that matters in the enhancement of memory by emotion. A more thorough review about potential mechanisms in the enhancement of memory by emotion is given in the context of age-related differences in remembering emotionally-toned material in Chapter 2.

In sum, the experimental approach to investigate links between emotion and memory has existed for over 100 years and comparisons have been made of memory for emotionally-toned material versus more neutral material using a diverse range of stimuli, tasks, and measures. The evidence from this literature supports the claim that *emotionally-toned material is better remembered than neutral material* across different tasks, different retention intervals, and different types of to-be-remembered material.<sup>2</sup> However, there is some evidence that the enhancement effect is stronger for free recall and long delays (i.e., days, weeks) rather than recognition and short delays (i.e., minutes). Although the experimental approach has its merits, controlled laboratory studies have the potential to investigate the underlying mechanisms of emotional memory.

### 1.3 MEMORY FOR POSITIVELY- AND NEGATIVELY-TONED MATERIAL

The evidence from naturalistic and experimental approaches suggests that emotionally-toned material is better remembered than neutral material. It is not known, however, whether this is a general advantage of emotional information in memory or whether

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<sup>2</sup> It should be noted that, although this dissertation focuses on the enhancing effect of emotional material on explicit memory, emotional stimuli could also sometimes impair memory, particularly if very high levels of arousal (e.g., rape) are elicited (Appelbaum, Uyehara, & Elin, 1997; Eysenck, 1976; Lupien & Brière, 2000; Parkin, 2000). Thus, I will limit the dissertation to the effect of normal levels of emotional arousal on memory rather than to the effect of traumatic events on memory.



there is a difference in the processing of negative and positive information that may influence memory functioning differently. This is the *question of differential processing prioritization for emotionally-toned material*, that is, whether information from one valence category (i.e., positive or negative) is selectively prioritized in the memory process.

### **1.3.1 Differential Processing of Positive and Negative Information**

This dissertation is embedded in a theoretical tradition, which argues that emotions are organized around two broad motivational systems that mediate goal-directed approach and defensive behaviors (e.g., Lang, Bradley, & Cuthbert, 1997; Watson, Wiese, Vaidya, & Tellegen, 1999). These systems are thought to deal with the complex requirements of the environment. The *approach system* is activated in positive contexts that promote survival, with a basic behavioral repertoire of ingestion, copulation, and caregiving. Conversely, the *defense system* is activated in contexts involving negative circumstances (e.g., threat), with a basic behavioral repertoire built on withdrawal, escape, and attack. These systems are thought to be implemented by neural circuits in the brain, presumably with common outputs to structures mediating the somatic and autonomic physiological systems involved in attention and action (Gray, 1990; Gray, Braver, & Raichle, 2002; LeDoux, 1994, 2000). Indeed, several neuroimaging studies have revealed differences in the neural circuits activated during processing of positive and negative information (e.g., R. J. Davidson, 1992; Tomarken & Keener, 1998). The recognition of negative words, for example, is associated with activity in right dorsolateral prefrontal cortex, left amygdala and hippocampus, right lingual gyrus and posterior cingulate cortex. Recognition of positive words, in contrast, is associated with increased activity in bilateral prefrontal and orbitofrontal cortices, and left temporal lobe (Maratos, Dolan, Morris, Henson, & Rugg, 2001).

On a behavioral level, numerous researchers have found differential effects of positive and negative information for cognitive processes. These differences in cognitive functioning have been linked with the two emotion systems (for reviews, see Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Rozin & Royzman, 2001; Taylor, 1991). Negative emotions, for example, signal that action needs to be taken, whereas positive emotions do not (e.g., Frijda, 1988; Schwarz, 1990). Negative affective states lead people to narrow and focus their attention to a greater degree than positive information (e.g., Broadbent, 1971). Negative aspects of an object, event, or choice are weighted more heavily than positive aspects in judgments (e.g., Kahneman & Tversky, 1984); and negative stimuli lead to more cognitive work and more complex cognitive representations than positive stimuli (see Peeters &

Czapinski, 1990). In accord with this, Taylor (1991) has suggested that negative information mobilizes available resources (physiological, cognitive, and social) to a greater extent than positive information do (see also Cacioppo & Gardner, 1999). This mobilization of the organism, however, is followed by counteracting responses in physiological, cognitive, and behavioral systems that minimize or even erase the impact of that information. Again, the recovery from an emotional reaction (i.e., minimization) is thought to be greater for negative than for positive events. This asymmetrical pattern for positive and negative information is called the *Mobilization-Minimization Hypothesis* (Taylor, 1991): stronger reactions but also stronger recovery for negative than for positive information.

Empirical support for the idea that negative entities (e.g., events, objects, information, traits) have a much greater psychological impact than positive entities can be found in several domains (e.g., attention, motivation, impression formation; for reviews see Baumeister, Bratslavsky et al., 2001; Rozin & Royzman, 2001; Taylor, 1991). From a conceptual perspective, this general negativity effect makes sense because the processing of negative information is often crucial for an organism's well-being, whereas the processing of positive information is less so (e.g., Taylor, 1991). In this context, a crucial feature differentiating positive and negative information is the greater time urgency of processing negative information compared with positive information. Positive events (e.g., reproduction) are important in the long-term outcome, but less pressing in the short-term. Rapid processing might be functionally unnecessary for positive information. In contrast, ignoring negative events (e.g., an approaching tiger) may lead to undesirable outcomes in the short-term.

Pratto and John (1991; see also Dijksterhuis & Aarts, 2003; MacKay, Shafto, Taylor, Marian, Abrams, & Dyer, 2004) propose that people constantly evaluate stimuli in their environments and that these evaluations take place automatically, outside of conscious awareness. These evaluations are assumed to be relatively simple, leading to a mere categorical distinction between positive and negative stimuli. They argue that negative information might attract more processing resources than positive information because the detection of negative stimuli is more critical for survival than the detection of positive stimuli. Not all negative stimuli threaten survival, but it may have been easier to evolve a simple detection mechanism for all negative stimuli than a specific detector of threatening stimuli (e.g., spiders). 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* (for a broader discussion of prioritized processing see Öhman, 1979).

Empirical support for a processing priority for negative information stems from various sources: For example, people report thinking more about negative than about positive events (e.g., Klinger, Barda, & Maxeiner, 1980), view negative pictures longer than positive pictures (e.g., Charles et al., 2003; Fiske, 1980), and have slower reaction times and more eyeblinks for negative than for positive words (Ohira, Winton, & Oyama, 1997). In particular, there is supporting evidence for emotion-based processing prioritization for negative information in a set of studies with the emotional Stroop task (Pratto & John, 1991; M. White, 1996). Trait words (e.g., honest, mean) were presented in different colors. Participants were asked to name the color as fast as possible. These studies showed that negative words produced longer response latencies than positive words suggestive of a processing bias for negative information. Based on this evidence, the authors conclude that “people’s attention is drawn to negative information without their intention and the cause of this effect lies in the valence of the traits” (p. 388). Bargh (1994) suggested that this finding shows differential processing of words for survival-relevant information. More recent findings are not always consistent with a general negativity effect in attention (Harris & Pashler, 2004; Mackintosh & Mathews, 2003; Mogg et al., 2000). These studies suggest that the emotional intensity of material (regardless of valence) also influences attention such that extreme unpleasant stimuli attract more attention than mildly unpleasant stimuli. Moreover, some extreme pleasant stimuli (i.e., pictures of erotic scenes) attract more attention than mildly unpleasant stimuli (e.g., A. K. Anderson, 2003; Buodo, Sarlo, & Palomba, 2002).

This idea of *emotion-based processing prioritization for negative information* is also consistent with evolutionary-oriented ideas on the significance of processing threat-related signals (e.g., Hansen & Hansen, 1988; Öhman, 1993; Öhman, Flykt, & Esteves, 2001; M. White, 1995). Namely, the detection of stimuli that threaten survival has more adaptive value than the detection of other stimuli and should be prioritized. However, the evolutionary threat hypothesis focuses on specific stimuli that present a threat to survival during the history of human evolution (e.g., snakes, spiders, angry faces). From a broader perspective, although not all negative stimuli are survival-relevant, negative stimuli in general transport significant information for the well-being of the organism.

Empirical evidence for evolutionary threat theory stems from studies with a visual search task: Participants were asked to indicate whether a particular target stimulus (e.g., a snake) is in an array of pictures or not. Participants tend to be faster to find a snake in an array with mushrooms than a mushroom in an array of snakes. Similarly, they are faster to

find an angry face in an array of happy faces than vice versa (Hansen & Hansen, 1988; Öhman et al., 2001).

Overall, there is evidence from diverse areas that positive and negative information differ fundamentally in their representation, function, and processing in the human brain. On a behavioral level, it might well be possible to observe differential effects of positive and negative stimuli on memory functioning as well.

### **1.3.2 Memory Differences for Positive and Negative Information?**

For our human ancestors, a memory system for the affective quality of events is highly important in differentiating good and bad food, friends and enemies, happy and sad faces. As reviewed above (see section *1.2 Memory for Emotionally-Toned Material*), there is consistent evidence that emotionally-toned material is better remembered than neutral material. The open question is whether positive and negative information are differentially well remembered, that is, whether there is a positive-negative disparity in emotional memory.

There is evidence from diverse areas that positive and negative information differ fundamentally in their representation, function, and processing in the brain (see section *1.3.1 Differential Processing of Positive and Negative Information*). For example, Pratto and John (1991) argue that negative information might attract more processing resources than positive information. Such a processing priority given to negative information could influence the memory system in that negative information would be remembered with more accuracy than positive information (i.e., negativity effect) when individuals have to memorize material composed of both positive and negative items (i.e., emotion-heterogeneous context; see Ochsner, 2000, for a similar argumentation). Indeed, Pratto and John found an advantage for negative words over positive words in young adults' memory.

From the clinical literature, there is as well some evidence that some populations show a positive-negative disparity in memory: Depressive patients show better memory for negative than for positive material (for reviews, see Blaney, 1986; Matt, Vázquez, & Campbell, 1992) and patients with panic disorders or with phobia show better memory for threat-related material (e.g., MacLeod & McLaughlin, 1995; Reidy & Richards, 1997). These findings are typically interpreted in terms of processing resources or processing priority: More resources are allocated in the processing of information that are explicitly relevant for a specific population. For example, spiders are explicitly relevant for spider phobia and negative ruminating thoughts are more relevant for depressive patients.

With regards to healthy adults, the findings, in general, suggest a negativity effect: In the literature on learning from situational contingencies, punishment of incorrect responses produces more effective learning than the reward of correct responses (e.g., Meyer & Offenbach, 1962; Penney, 1968; Penney & Lupton, 1961; Spence, 1966; Spence & Segner, 1967). For example, Tindall and Ratcliff (1974) investigated 540 first, fourth, and eighth graders under three conditions: In a reward condition, children received a token for correct responses; in the punishment condition, children were exposed to a loud noise for incorrect responses; and in a reward-punishment condition, they received both treatments. Children performed significantly better in the punishment condition than in both other conditions. Children's age did not show an interaction with the experimental conditions, suggesting that punishment is relatively more effective than reward across all grade levels. In the literature on impression formation, sentences describing people's undesirable behaviors are better recalled than sentences describing people's desirable behaviors or traits (e.g. Bless, Hamilton, & Mackie, 1992; Dreben, Fiske, Hastie, 1979; Skowronski & Carlston, 1987). Moreover, young participants recognized negative items better than positive ones (Robinson-Riegler & Winton, 1996).

There are, however, some studies reporting a positivity effect in healthy young adults for self-relevant information. In these studies, memory for self-relevant information is biased in the direction of enhancing the self. For example, Skowronski and colleagues (Skowronski, Betz, Thompson, & Shannon, 1991) compared memory for everyday life events for both the self and for another person (e.g., friend, spouse). In the recall of another person's events, they found no memory difference in recall for the positive and negative events, but a memory bias in favor of the pleasant events for the self. Thus, there is a tendency for individuals to recall more positive than negative information from one's own life (i.e., self-enhancement effect).

Despite this positive view of one's own past, the findings in the literature on memory for emotionally-toned material generally indicates a negativity effect. The specific enhancement of memory by negative information suggest that negative information receives more thorough processing when it was encoded and is, therefore, retained in a more elaborate memory trace.