selective priming effect can be discussed in relation to an automatic integration process which has not been observed in the supraliminal priming condition or in the explicit free recall test (Bradley et al., 1994).

According to Bower's (1981) model, mood congruent effects are explained by emotional nodes in a relational network. Emotional nodes are linked with other memory representations such as happy or sad memories and are activated automatically when activation spreads through the network. Activation of emotional nodes is associated with increased accessibility of mood-congruent information. Because the model does not make differential predictions concerning implicit and explicit memory processes, it is useful in the explanation of anxious or depression-congruent effects in implicit memory. Strategic effects of subjects during explicit memory tests have been discussed to be responsible for the failure to consistently find the proposed mood-dependent effects in explicit tasks.

What becomes evident from this more general overview, is that effects of emotional experiences on implicit memory processes can be observed under certain circumstances. This also holds true for processing in the unprimed lexical decision task, where incidental effects of emotional valence are observed in some studies while others fail to find them. These aspects as well as methodological concerns that might also contribute to the inhomogeneous literature findings will be the focus of the chapters 2 - 4.

Emotion and explicit memory

The cognitive domain where the influence of emotional experiences is best understood is explicit memory. From an evolutionary perspective, enhanced memory for emotionally significant events has an adaptive value because it predicts 'biologically important occurrences when similar events are re-encountered in the future' (Dolan, 2002). Accordingly, different studies found that individuals typically remember emotionally significant material better than neutral material (for reviews see Christianson, 1992; Hamann, 2001; Ochsner, 2000). An extreme example of an enhancement effect stems from naturalistic approaches examining the above mentioned 'flashbulb memory'. Exceptional, highly vivid memories are created when sudden, surprising events that have high emotional significance are encountered. In their classic study, Brown and Kulik (1977) found that the higher the degree of novelty and consequentiality associated with an event is rated (e.g., the assassinations of Martin Luther King or John F. Kennedy), the higher is the likelihood of remembering in great detail the circumstances in which the news were acquired. Support for the flashbulb hypothesis has been observed for happy and sad events of political and social life, autobiographical events, and eyewitness memory (Christianson, 1992; Conway, 1995; Reisberg, Heuer, McLean, and O'Shaughnessy, 1988; Walker, Vogl, and Thompson, 1997;

Winograd and Neisser, 1992). However, despite their high vividness and their highly rated imagery it has been suggested that flashbulb memories may sometimes not be as accurate as they seem to be. Neisser and Harsh (1992) asked subjects one day after the challenger explosion in 1986 and again 3 years later about the situation when they first heard the news. Although the subjects reported highly vivid memories, they were often simply wrong.

The possibility exists, that this loss in accuracy over time reflects the flexibility and reconstructive power of the mental system instead of questioning the original vividness of flashbulb memories. According to the 'Easterbrook hypothesis', emotion has been hypothesized to produce a narrowing of attention (Easterbrook, 1959). Attentional resources are allocated to central features of an emotional event, and encoding of the surrounding peripheral details is less sensitive. As a result, central details of emotional events are better retained than peripheral details or the corresponding central details in neutral events (Heuer and Reisberg, 1990; 1992; Christianson and Loftus, 1987). Heuer and Reisberg (1990) reported that subjects who saw an emotional version of a slide story remembered more central and more detailed information than did subjects who were presented a neutral slide story in a surprise recognition test two weeks later. It should be noted, though, that different studies failed to replicate the predictions of the 'Easterbrook hypothesis' when they observed enhanced memory for both, central and peripheral information (for a review see Heuer and Reisberg, 1992).

However, the evidence from the literature supports the idea that memory for emotional content is enhanced even when the emotional intensity of the material is low, as is the case in typical laboratory studies. In such controlled laboratory experiments of explicit recognition memory, subjects are presented either a set of emotional stimuli or a set of neutral control stimuli designed to be as similar as possible to the emotional stimuli, but lacking their emotional connotation. As a result, it has been consistently found that the probability to remember a positively or negatively valenced word, picture or slide sequence is increased compared with neutral material in free recall tasks (Bradley et al., 1992; Cahill and McGaugh, 1995; Christianson, 1992; Danion et al., 1995; Doercksen and Shimamura, 2001; Hamann, Ely, and Grafton, 1999; LaBar and Phelps, 1998; Phelps, LaBar and Spencer, 1997; Talmi and Moscovitch, 2004).

When looking at recognition tests, where subjects have to indicate whether they have previously studied an item, the results appear to be less clear. Using a recognition task, Maratos and colleagues observed that more 'old' responses are given in relation to emotional items, independent of whether the item is actually old or new (Maratos, Allen, and Rugg, 2000; Maratos and Rugg, 2001). This tendency has been explained in terms of an '*emotion induced recognition bias*', which may reflect an adaptive elementary cognitive mechanism

that ensures that an event with potentially high survival value is not missed (Windmann and Kutas, 2001).

In contrast, Maratos et al. (2000) related this pattern of data to effects of semantic cohesiveness: Negative items are thought to represent a semantic category with strong inter-item associations, leading to higher false alarm rates for negative material in a recognition task. However, McNeely, Dywan, and Segalowitz (2004) showed that it is not semantic cohesiveness per se that explains the recognition bias for negative material. According to their results, emotionally salient words seem to be more fluently processed, even when compared with highly cohesive categorized neutral material. Through arousal-mediated processes at encoding and retrieval, emotional content might serve as an organizing and binding factor for memory processes (Talmi and Moscovitch, 2004).

In addition to an enhanced response bias, it has been suggested that emotional items are not recognized better than neutral ones in verbal recognition tasks (Danion et al., 1995; Maratos et al., 2000; Windmann and Kutas, 2001), whereas enhanced performance has been observed in recognition tasks focussing on emotional context effects in sentence processing (Maratos, Dolan, Morris, Henson, and Rugg, 2001) or pictoral backgrounds (Erk, Martin, and Walter, 2005; Smith, Henson, Dolan, and Rugg, 2004).

An explanation of these discrepancies emphasizes differences in the processes underlying recognition and recall performance. Recognition tasks have been suggested to differ more generally in terms of retrieval cues and the kind of response that they require (Yonelinas, 2002). Since no retrieval cues are given, recall has been thought to be based on more elaborative, strategic processing, whereas recognition performance may be based more on automatic and context-dependent familiarity-based processes. As a result recognition test performance is more susceptible to response biases as observed using emotional material, e.g., the emotion-induced response bias or overshadowing of emotional valence effects due to the given contextual cues similar to the overshadowing effects in implicit memory tasks.

Accordingly, enhanced recognition of emotionally valenced words was evident in source memory tasks which have been related to recollective processes (Doercksen and Shimamura, 2001; Kensinger and Corkin, 2003), and in a remember/know recognition paradigm using picture stimuli that are thought to provide more contextual cues than do words (Ochsner, 2000). In the remember/know paradigm subjects are forced to indicate whether they '*remember*' (recollection-based response) or '*know*' (familiarity-based response) if a presented item has been studied before. Furthermore, Ochsner (2000) observed that '*remember*' responses were enhanced for negatively valenced pictures, whereas positively valenced pictures elicited more '*know*' answers. In addition to these

valence-specific effects on recognition, an effect of emotional arousal was observed, when high arousing pictures were better recollected compared with low arousing pictures.

Emotional valence and emotional arousal are thought to represent orthogonal axes in a two dimensional space (Bradley et al., 1992; Lang, Bradley, and Cuthbert, 1990; Osgood, Suci, and Tannenbaum, 1957, Reisenzein, 1994; Wundt, 1896). Going back to Wundt's 'Theory of Emotion' which states that basic emotions can be grouped along two basic emotional states, namely pleasure-displeasure and arousal (see Reisenzein, 1994), emotional stimuli are proposed to vary from positive (pleasant) to negative (unpleasant) on the valence dimension and from calm to exciting on the arousal dimension. It is suggested that positive and negative words are more arousing than neutral words, as long as the stimulus material is not controlled for the arousal dimension. According to this dimensional approach, it can be questioned whether positive and negative valence affect recognition or whether it is the degree of increased arousal that determines the recognition of emotional material (Christianson, 1992; Bradley et al., 1992). Only recently, research has begun to directly contrast the effects of valence and arousal (Dolcos, et al.,2004; Kensinger and Corkin, 2003, 2004; Ochsner, 2000).

It has been argued that positive and negative information might be processed differently by the cognitive system. Negative information is suggested to attract more processing resources than positive information (Dijksterhuis and Aarts, 2003; MacKay, Shafto, Tayler, Marian, Abrams, and Dyer, 2004; Pratto and John, 1991). This has been explained by the emotion-based processing prioritization for negative information (Öhmann, 1979, Cacioppo and Gardner, 1999; also see Kensinger and Corkin, 2003; Ochsner, 2000), where the processing of negative stimuli is more critical for survival of the organism. Accordingly, Kensinger and Corkin (2003) have emphasized that negative information might be remembered with more accuracy, as revealed by higher recollection scores. In contrast, positive material was suggested to be better interconnected in memory than negative material (Ashby, Isen, and Turky, 1999; Isen, 1985) which goes in line with the observed pattern of enhanced familiarity responses in recognition tasks for positive material (Ochsner, 2000).

Neuroanatomy of memory for emotional material

One of the major research questions regarding memory and emotion is whether special processes are needed to explain the enhanced memory for emotional material (Hamann, 2001). As outlined above, it seems likely that effects of emotional material on memory processes can be explained by ordinary cognitive mechanisms, like the attracting of attentional resources, enhanced integration and elaboration of memory representations, and