Chapter 5
Biopsychosocial Perspectives on Memory Variability in Eyewitnesses

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Introduction

Eyewitness memory has evolved into an umbrella term to account for the memory of criminal actions witnessed by victims, bystanders, and committed by perpetrators. Encompassed by the narrative memory of a crime as well as recognition memory for the perpetrator, eyewitness memory plays an important role in the criminal justice process—from the initial investigative interview by law enforcement to the assessment of credibility by the triers of fact. In an effort to assist criminal justice

The authors are grateful to Kristin Kendrick, Dr. Dorothee Griesel, Dr. Marguerite Ternes, Dr. Caroline Greaves, and Dr. Sven Christianson for their helpful comments on earlier drafts of this chapter. Separate parts of this chapter were presented at the Canadian Psychological Association's 2002 Annual Convention, the Society for Applied Research on Memory and Cognition's 2003 Conference, and the Society for the Scientific Study of Psychopathy's 2005 Conference. This chapter is a partial reproduction of a previous chapter (Hervé, Cooper, & Yuille, 2007), and permission to reprint the tables and figures has been received. Please address all correspondence concerning this chapter to: Hugues Hervé, Ph.D. at hherve@theforensicalliance.com.

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B.S. Cooper et al. (eds.), *Applied Issues in Investigative Interviewing, Eyewitness Memory, and Credibility Assessment*, DOI 10.1007/978-1-4614-5547-9_5,

system professionals, researchers—mostly psychologists—have empirically investigated the variables associated with eyewitness memory for over 100 years (e.g., Stern, 1904). In fact, thousands of studies have been conducted in the area, making the study of eyewitness memory one of the largest subfields in the area of forensic psychology. The impressive quantity of literature is, however, daunting in nature when one attempts to make sense of the discrepant empirical findings. Indeed, consistent with clinical-forensic experience, the results from eyewitness research indicate that different witnesses to the same criminal event can produce widely variable memory patterns. Without a unifying evidence-informed model to explain the different memory patterns observed, criminal justice professionals are faced with a difficult task when attempting to makes sense out of the variable nature of eyewitness memory.

In this chapter, the different eyewitness memory patterns observed in research and clinical-forensic practice are reviewed. Additionally, perspectives from our biopsychosocial model of eyewitness memory are offered to assist in explaining this memory variability. Parts of this model were previously disseminated to explain memory formation in offenders in response to their own criminal actions (see Hervé, Cooper, & Yuille, 2007). However, the model was developed with a larger scope in mind—to explain the memory patterns in all types of eyewitnesses, including victims and bystanders, the focus of the present chapter. In the following sections, certain underlying assumptions are discussed, including the nature of crime (i.e., the stimulus event) and the multidimensional nature of emotion. Thereafter, memory patterns are reviewed and central aspects of the biopsychosocial model are presented. Following a summary of biopsychosocial predictions, this chapter concludes with a few implications for investigative interviewing, researching eyewitness memory, assessing credibility, and providing expert testimony.

The Nature of Crime: The Stimulus Event

To understand eyewitness memory, one must first be knowledgeable about the events that provide the stimulus for subsequent remembering. Indeed, eyewitness memory does not exist without a crime. Although a complete review of criminal acts is beyond the scope of this chapter, certain basic features are noteworthy. First, there are three basic conditions that must exist in order for a crime to be committed: (1) the offender must be motivated to act (i.e., with or without ill intent); (2) the offender must overcome internal inhibitors; and (3) the offender must overcome external inhibitors (Hervé, Cooper, & Yuille, 2012). In addition, when offences are interpersonal in nature, often, the offender must also overcome the victim's resistance. These factors are relevant to the present focus, as they may exert an impact on aspects of the to-be-remembered event as well as on the resultant memory for said event. For example, criminal motivation (e.g., instrumental vs. reactive) has been shown to affect perpetrators' memory for violent crimes (Cooper & Yuille, 2007). Similarly, factors that are used to overcome inhibitors (e.g., intoxicants) may

have their own impact on eyewitness memory (Read, Yuille, & Tollestrup, 1992; Yuille, Tollestrup, Marxsen, Porter, & Hervé, 1998). How the victim's resistance was overcome is not only relevant to the criminal investigation but can also have various effects on the victim (i.e., from no effect to a traumatic effect; Cooper, Kennedy, & Yuille, 2004; Griesel & Yuille, 2012) that may also influence memory formation. Indeed, research has shown that post-traumatic stress disorder (PTSD), a disorder not uncommonly experienced by individuals exposed to crime/trauma, has complex effects on memory (Klein, Caspi, & Gil, 2003; Southwick, Morgan, Nicolaou, & Charney, 1997).

Second, offences can vary in terms of the number of to-be-remembered events, with some events lasting only seconds and others lasting hours or days (e.g., robbery vs. unlawful confinement, respectively); some offences consist of only one act while others involve several (e.g., assault vs. stalking, abduction and sexual assault, respectively); and some offences involve a limited number of people while others involve numerous perpetrators, victims and bystanders (e.g., a sexual assault vs. a terrorist act, respectively). No doubt, these characteristics have memory consequences that should be considered in combination in light of the dynamic nature of crimes. Third, different offences induce different levels of stress/trauma[1] in those involved. While some offences, such as frauds, induce little-to-no stress in individuals (e.g., at the time of the fraud), more intrusive and violent offences are known to trigger a great deal of stress/trauma in victims and/or bystanders and perpetrators (Darves-Bornoz, Pierre, Lepine, Degiovanni, & Gaillard, 1998; Griesel, Cooper, & Yuille, 2004; Griesel & Yuille, 2012; Pollock, 1999). Finally, prior criminal experience impacts how individuals respond to a particular criminal act. As they gain experience, some perpetrators are likely to become increasingly comfortable conducting a particular form of crime, which may serve to reduce the stress associated with that behavior. Moreover, victims and bystanders of crime can either be sensitized or desensitized by prior criminal acts (see Connolly & Price, present volume). As discussed below, the emotional impact of criminal acts on those involved is central to memory formation and, therefore, needs to be clearly understood when investigating eyewitness memory.

Multidimensional Nature of Emotion

As with others, we assume that eyewitness memory is partly mediated by the witnesses' emotional response at the time of the experienced event and/or upon subsequent recall (Christianson, 1992). However, we assume that this emotional response

[1] For the purposes of the present chapter, we accept, in part, the following definition of trauma provided by the American Psychiatric Association (APA, 2000): "actual or threatened death or serious injury, or a threat to the physical integrity of self and others" (p. 467). In our view, trauma is related not only to the nature of the event (e.g., threat to life or limb) but to the traits and states of the eyewitness as well.

is more complex than previously proposed. While previous theories and theorists have utilized a unidimensional view of emotions (e.g., Easterbrook, 1959; Yerkes & Dodson, 1908), we have adopted a multidimensional perspective. Most theorists of emotional processing agree that emotional experiences depend on two correlated, yet independent mechanisms: a biological system that mediates arousal responses to emotional events (e.g., crimes) and a cognitive-interpretative system that evaluates the significance of emotional events (Charland, 1997; Power & Dalgleish, 1999). It is believed that each system, when activated, continuously feeds back information to the other system. Within this framework, arousal refers to the physiological activity produced by the autonomic nervous system (ANS; Critchley, 2005). The arousal, which is non-specific (i.e., does not differentiate between emotions), solely sets the quantitative specifications for emotional life. In other words, arousal alone does not produce an emotional response (e.g., Bockheler, 1995; Schachter, 1971; but see Levenson, 1988, 1992). The arousal must be perceived as emotional in nature rather than being solely due to physiological activation (Russell, 1989). The autonomic arousal, however, serves to prepare us, at the physiological level, for action, while concurrently signalling the mental organization for attention, alertness, and scanning of the environment—all variables that are likely to have an impact on eyewitness memory.

The cognitive-interpretative system performs a meaning analysis of the emotional (e.g., criminal) event (Mandler, 1984). Mediated by the central nervous system, this mechanism ascribes the particular quality (e.g., pleasant vs. unpleasant) of the felt emotion which, in turn, serves to either decrease or increase subsequent ANS arousal (i.e., the cognitive-interpretive system has either a physiological activating or deactivating effect; Russell, 2003). Although these meaning analyses may be influenced by arousal, they are primarily set by the general situation and cognitive state of the eyewitness, factors that could also affect eyewitness memory. It is the joint product of both of these systems—arousal and meaning analysis—which construct emotions as currently defined. As noted by Mandler, "arousal provides the intensity of the emotional state, and cognition provides its quality" (p. 119). It thus follows that, since affect mediates responses to traumatic/stressful events (e.g., crimes), eyewitness memory research should consider the impact of each of these systems, both in isolation and in combination, and how these may differ across individuals and/or situations. As discussed below, an eyewitness' sensitivity to arousal—reflecting both autonomic and interpretive components—is a major factor used to explain memory variability.

The Reconstructive and Variable Nature of Eyewitness Memory

Eyewitness memory research conducted over the past century has provided a firm foundation underlying two general principles of memory. First, memory is not reproductive but reconstructive in nature (Schacter, 1996; Yarbrough, Hervé, & Harms, present volume). This holds true whether the to-be-remembered event

is a stressful/traumatic crime or a positive experience. Because memory is reconstructive, the account of an event will usually differ across retellings. Although the gist of an account of an event can remain largely unaltered, it is usually the case that, upon retellings, new details are added and old details are omitted (Erdelyi & Kleinbard, 1978). As Conway (1997) suggested, this is thought to occur because "memory construction is mediated by control processes which vary from one recall to the next and use different cues to probe autobiographical knowledge on different occasions of retrieval" (pp. 4–5). Presumably, the more efficient the control processes and/or the greater the number of available cues, the more detailed the memory will be from one account to the next. Note, however, that increased memory detail does not necessarily translate to accurate recall.

Second, as indicated above, it is clear from the eyewitness literature and clinical-forensic experience that witnesses to events display a variety of memory patterns. Indeed, the following ten memory patterns have thus far been identified (Hervé et al. 2007; Yuille & Daylen, 1998): normal forgetting, active forgetting, dissociative amnesia, state dependent memory, red out, remarkable memory, script memory, dissociative memory with either an external or internal focus, and created memory. These patterns are descriptions of consistent forms of eyewitness recall, in terms of both quality and quantity, representing a mixture of processes (e.g., forgetting, anger) and products of processes (e.g., red out) and, as such, can co-occur. The first five (i.e., normal forgetting, active forgetting, dissociative amnesia, state-dependent memory [SDM] and red out) concern different patterns of memory loss. Remarkable memories and script memories, in contrast, are patterns associated with long-term retention. Dissociative memories reflect event-related processes (e.g., dissociation) that affect the quality of memory. Finally, created memories are a product of suggestion, not of events and, therefore, affect quality. The evidence supporting these patterns is reviewed below followed by biopsychosocial explanations to explain the variability.

Normal Forgetting

Normal forgetting occurs for routine, everyday events, such as driving to work or shopping (Yuille & Daylen, 1998). When such a routine experience occurs, the memory is initially good but, barring any unexpected event of impact, a loss of memory detail over time usually transpires. Normal forgetting is the pattern of memory that has been routinely examined with the analogue (e.g., simulation) method of eyewitness memory. In these studies, the modal stimuli are crime simulations (e.g., videos of criminal acts). Most people forget many aspects of events viewed in the laboratory, especially those of a peripheral nature (e.g., Loftus & Burns, 1982). Actual victims of fraud also exhibit normal forgetting as, at the time of a typical fraud, the victim is usually unaware that a crime is being committed (Tollestrup, Turtle, & Yuille, 1994). The mundane nature of the event (e.g., a normal

transaction) likely results in relatively superficial encoding that is susceptible to both erosion (e.g., via transience; Schacter, 2001; Yarbrough et al., present volume) and distortions (e.g., source confusion; Deffenbacher, Bornstein, & Penrod, 2006). Normal forgetting may also apply to some aspects of a stressful/traumatic event such as a violent crime. Although such events of impact may lead to a remarkable memory (see below) of the central details, the peripheral details may be recalled immediately but forgotten with the passage of time.

Active Forgetting

As with normal forgetting, active forgetting concerns memory loss; however, this pattern is a consequence of a conscious attempt to forget an event (Yuille & Daylen, 1998). It involves avoiding recalling the event and such may reduce the details available to memory. Conversely, active forgetting may lead to memory enhancement as avoiding a memory of an experience has been empirically demonstrated to be related to having intrusive memories of that experience (Cooper, 2005). Active forgetting and normal forgetting differ, as the precipitating events that lead to active forgetting are typically emotional events (e.g., crimes) while those that lead to normal forgetting are typically routine events.

Dissociative Amnesia

Dissociative amnesia, the inability to recall all or part of an event of impact (APA, 2000), such as a crime, is the result of poorly understood processes. The amnesia may develop at the time of the event or after some delay and may be circumscribed or selective (Yuille & Daylen, 1998). This type of amnesia is psychologically based, not the product organic processes (e.g., brain damage; intoxicants; Caine & Lyness, 2000). Dissociative amnesia is thought to be resistant to state specific effects unlike amnesia resulting from state-dependent processes (see below). Studies of abused victims (e.g., Christianson & Nilsson, 1989; Darves-Bornoz, 1997; Mechanic, Resick, & Griffin, 1998), combat veterans (Southwick et al., 1997), and survivors of natural disasters (Koopman, Classen, & Spiegel, 1994) have produced this pattern of memory, although it occurs rarely.

As with active forgetting, dissociative amnesia is distinguished from normal forgetting as the precipitating event is one that the person should recall (e.g., an event of personal significance such as a crime)—this pattern of memory is associated with stressful/traumatic experiences as opposed to routine events that are subjected to normal forgetting. Although normal forgetting can lead to a permanent loss of memory, clinical-forensic experience suggests that dissociative amnesia can reverse itself, typically in the presence of a potent event-related cue. In such cases, the memory typically comes flooding back.

State-Dependent Memory

SDM refers to the finding that we are better able to remember an event when tested in the same state (e.g., physical environment) in which we experienced the event (e.g., Godden & Baddeley, 1975; Goodwin, Powell, Bremer, Hoine, & Stern, 1969). In addition to our physical environment, statement-dependent memory is affected by a variety of stimuli such as odours, music, and internal states (e.g., Eich, 1987, 1995; Reisberg, 1997). Thus, memory suffers if the context between encoding and retrieval is discrepant and, conversely, memory is facilitated when the context is similar across encoding and retrieval. Given, in part, the unique nature of criminal events, it is only reasonable to assume that state-dependent effects may occur. Presumably, reinstating the state the individual experienced while experiencing an offence could lead to memory retrieval, be it in part or in whole. There are, in fact, clinical examples of individuals recalling past traumas when facing new stressful/traumatic situations (i.e., a similar emotional state), as well as when being returned to the scene of a crime (i.e., a similar cognitive/experiential state). The Cognitive Interview (Fisher & Geiselman, 1992) capitalizes on SDM effects by virtue of the context reinstatement step, which is used to increase memory (note: this is also used as an enhancement step with the Step-Wise Interview, adapted for adults; Cooper, Hervé, & Yuille, 2012).

Red Out

This pattern is of concern when a witness' emotional state during an event becomes altered by extreme negative valence (e.g., anger). In fact, it has been suggested that it is possible to become so enraged that a different state of consciousness is attained (Swihart, Yuille, & Porter, 1999). In this state of "catathymia" (Dutton & Yamini, 1995), or in a "red out" the perpetrator is thought to act in a rigid, derealized manner, and is later amnesic for the violent act committed. The acts leading up to and following the violent incident are, however, thought to be available in memory. Thus, in a red out, amnesia is circumscribed to only the violent aspects of the incident. This is consistent with various understandings of some forms of amnesia (Guttmacher, 1960; O'Connell, 1960; Tanay, 1969). Indeed, strong emotions can contribute to amnesia, an effect that occurs irrespective of intoxication (Parwatikar, Holcomb, & Menninger, 1985). There are, in fact, many instances of domestic violence where the offender has claimed amnesia for a battering incident, and in some instances for a murder, in the absence of alcohol ingestion (Dutton, 1995). While many of these cases could be construed as examples of malingered amnesia in an attempt to lessen or divert criminal responsibility (Hervé & Cooper, 2008), there are cases in which the offender admitted responsibility and provided a detailed memory for certain reprehensible acts such as necrophilia but claimed amnesia for less-shocking criminal actions such as multiple stabbings (Porter, Birt, Yuille, & Hervé, 2001).

The biopsychosocial basis for red outs is not entirely clear. Red outs may be a unique case of dissociative amnesia. More likely, red outs may occur as an extreme

form of a SDM effect and, if state dependent, it follows that the memory may be retrievable. Such is only likely to occur if the person experiences the same state of rage that was exhibited during the original incident. While theoretically appealing and supported by anecdotal evidence (Cooper & Yuille, 2007), ethical restrictions rightfully preclude researchers and practitioners from returning offenders' mental states to the time that they committed acts of rage-induced violence.

Although thought to be restricted to the perpetrator context, in theory, red outs may occur in victims and witnesses to crimes as well. That is, it could be the case that a victim becomes so enraged by his/her victimization as to experience a red out. However, to date, there is no anecdotal or empirical evidence to support the red out pattern in those other than perpetrators of violent crime.

Remarkable Memories

Precipitated by events of impact, remarkable memories are vivid, detailed, and generally accurate recollections retained over long intervals (Leitch, 1948; Terr, 1991; Yuille & Daylen, 1998). Remarkable memories (RM) may be maintained via repeated recall, either to others or to oneself (Scrivner & Safer, 1988). Events leading to this pattern of memory are unique and consequential and occur in the context of high arousal and either positive or negative valence (Cooper, Hervé, & Yuille, 2003). As an example, in the first field study of actual eyewitness memory, Yuille and Cutshall (1986) demonstrated that witnesses to a shooting were detailed and highly accurate in their accounts, with little loss of accuracy over a period of months. Other field studies of witnesses to and victims of actual crime (e.g., Cutshall & Yuille, 1989; Griesel & Yuille, 2012; Odinot, Wolters, & van Koppen, 2009), as well as victims of disasters (Thompson, Morton, & Fraser, 1997), have replicated this memory pattern.

Laboratory-based methodologies are, for ethical reasons, unable to evoke remarkable memories as the stimuli used cannot produce extreme stress or trauma. Yet, findings from analogue research, which generally reflect the normal forgetting pattern, have been generalized to explain the memory consequences of experiencing events of impact (e.g., Loftus, 2012). Expert witnesses have testified in court that the pattern of recall found in analogue studies applies to a sexual assault victim, or a witness to a murder, or a witness to another type of violent criminal event (Cooper, Hervé, & Yuille, 2010). For instance, in a 1995 International Criminal Tribunal, a psychologist testified about analogue research regarding the effects of stress on memory, and the weapon focus effect. Without noting the limitations of the research (e.g., ecological validity), she extended the findings from the laboratory to the field, reporting that the research examined "the effects of extreme stress or the effects of experiencing something very violent or the effects of experiencing an event that involves a weapon" (p. 604; *Tribunal* vs. *Anto Furundzija*). Participants in analogue research, however, do not *experience* extreme stress or *experience* something very violent. Rather, they view stimuli under the conditions of low stress. Unfortunately,

this mixing of "apples and oranges" has produced confusion in the field (Yuille, Ternes, & Cooper, 2010).

Clearly not all events of impact lead to remarkable memories. Indeed, as indicated above, there are many examples of victims of crime developing the opposite pattern—dissociative amnesia. How do situations of high stress/arousal lead to poor memory in one witness and excellent memory in another? We believe this state of affairs is explained by the complex effects of stress/trauma on memory (Yuille & Tollestrup, 1992), effects that have biopsychosocial underpinnings (Yuille & Cooper, 2012; see below).

Script Memory

A script memory (SM) reflects a blending together of similar episodes into one's script (Ceci & Bruck, 1993). We all have scripts. For example, a script of our childhood birthday parties could involve our parents having our friends gather, receive presents, and eat birthday cake, etc. There are also script memories of repeated crimes (e.g., childhood sexual abuse, domestic violence; see Paz-Alonso, Ogle, & Goodman, present volume). Indeed, it is not uncommon for victims of repeated abuse to have a general recollection of "what used to happen" (King & Yuille, 1987). The repeated episodes of abuse may become blended together into a script unless a specific action deviated from the general way the abuse "used to" transpire—a script violation (see Yarbrough et al., present volume). Script memories are distinguished from narrative memories of specific events by a distinctive linguistic presentation style—script memories are usually recalled in a generalized manner with the use of tense-less verbs (Nelson & Gruendel, 1981). For example, in a study of memory for violence in sex trade workers, a few of the participants had script memories for the repeated sexual abuse they suffered as children—invariably, their memories for the abuse commenced with the phrase "he used to" (Cooper, 1999). Script memories, particularly script violations, may be retained for long periods of time, unlike memories that have been subjected to normal forgetting (Yuille & Daylen, 1998).

Dissociative Memories

The study of dissociation—a psychological response to trauma—and its cognitive impact has a rich clinical history (Janet, 1920; van der Kolk, 1996; van der Kolk & van der Hart, 1989). The general premise is that normally integrated mental processes such as memory and emotions can be separated through the process of dissociation (APA, 2000; Cardeña, 1994; Holtgraves & Stockdale, 1997). An individual who dissociates during an event may experience symptoms of depersonalization ("I do not seem real") and/or derealization ("the world does not seem real"; Marmar & Weiss, 1994); the event may appear to unfold very slow or very fast, and the

person might experience the event as an "out of body experience" (Cooper, Kennedy, & Yuille, 2001). Research indicates that a variety of events may lead to a dissociative response including physical and sexual abuse (Chu & Dill, 1990; Darves-Bornoz, 1997; Dunmore, Clark, & Ehlers, 1999; Herman, 1996; Spiegel & Cardeña, 1991), natural disasters (Koopman et al., 1994), torture (Weisaeth, 1989), and combat (Marmar et al., 1994). It is thought that dissociation renders the initial psychological impact of the event less intense (Chu, 1998; Spiegel, 1993).

Research and clinical experience suggest that a witness to a crime who dissociates during the event may focus on aspects of the event or on aspects of his/her response to the event or a combination of both (Yuille & Daylen, 1998). These two styles are discussed below.

Dissociative Memory: External focus

When an eyewitness dissociates during a criminal experience and has an external focus, they may view the event from a field or observer perspective (Schacter, 1996; Yuille & Daylen, 1998). In terms of the latter, the eyewitness may perceive an event as would an external observer (e.g., akin to an out of body experience) either at the time of the event and/or upon recall (Nigro & Neisser, 1983; *R v. Stephens*, 2000; Robinson & Swanson, 1993; Spiegel, 1993). Such alteration in perception/memory involves the "observer" viewing the event and themselves from a detached, alternative viewpoint (e.g., Hillman, 1981), arguably serving the function of "depersonalizing" an experience/memory (Terry & Barwick, 1995; van der Kolk, McFarlane, & Weisaeth, 1996). The validity of observer perspectives notwithstanding (Cooper, Cuttler, Dell, & Yuille, 2006; Cooper, Yuille, & Kennedy, 2002), the veracity of the observer memories remains unknown; no research has examined the accuracy of observer perspectives/memories in actual eyewitnesses. The triers of fact would surely welcome research on the accuracy of memories of criminal events experienced from observer perspectives, an area in need of empirical attention.

Dissociative Memory: Internal focus

This pattern occurs when an eyewitness dissociates during a crime and takes an internal focus. That is, eyewitnesses may focus internally on their emotions or on their physiological processes. For example, in one study, an eyewitness to a stabbing who dissociated during the experience stated the following, "I just remember being scared … thinking that something else may happen but not knowing what"; he had no memory for the event, per se (Cooper et al., 2003). Scant attention has been devoted to understanding this phenomenon, although it is likely the case that an internal focus results in the encoding of little event-related information but significant subjective information (Yuille & Daylen, 1998). Indeed, clinical anecdotes suggest that some individuals dissociate into fantasy when facing traumatic/criminal experiences. For example, some victims of repeated child sexual abuse have reported using a number

of strategies to cope with their sexual abuse, including dissociating, isolating their affect, and daydreaming in order to mentally escape the reality of their abuse (Darlington, 1996). Irrespective of one's internal focus (e.g., emotions vs. thoughts), dissociating away from the event of impact appears to serve a protective factor (e.g., enables one to subjectively avoid the traumatic/criminal event, thereby decreasing the acute affective intensity/subjective distress).

Created Memory

This pattern concerns a false/illusory memory, which research suggests is typically developed through suggestive influence in both victims (Lindsay & Read, 1994; Loftus, 1993; Loftus & Pickrell, 1995; Porter, Yuille, & Lehman, 1999) and offenders (e.g., false confessions; Gudjonsson, 1992; Ofshe, 1992). It seems clear from the literature that people can be led to believe that they have experienced events that did not actually transpire, the consequences of which could be severe (Bala, 1996; Brown, Scheflin & Hammond, 1997; Lazo, 1995; Leo, 1998; Loftus, 2012; Vella, 1998). Research suggests that it is the combination of individual difference variables and situational factors that facilitates the creation of a false memory. For the person with a false memory, this includes having both an introverted and dissociative personality, and being repeatedly interviewed by an extroverted authority figure with the use of questionable techniques (e.g., guided imagery, suggestion; Porter, Birt, & Yuille, 2000). It is clear that more research needs to be conducted before any firm conclusions can be made concerning the variables that influence the development of a created memory (CM).

Summary of Memory Patterns

The aforementioned review demonstrates that eyewitness memory is a highly variable phenomenon—some eyewitnesses have poor memory for their experiences while others have excellent memory; still others may have a memory pattern in between such polar opposites. The above memory patterns are not mutually exclusive (Yuille & Daylen, 1998). For instance, an eyewitness to a murder may have a remarkable memory for the central details of the event but show normal forgetting for peripheral aspects of the event (Yuille & Cutshall, 1986). Conversely, a victim of a sexual assault may have dissociative amnesia for the sexual component of his/her experience (Christianson & Nilsson, 1989) but demonstrate a remarkable memory for the events that led up to the attack. In addition, the list of memory patterns is not thought to be exhaustive of all possible eyewitness memory outcomes. Clearly, other patterns could be added via the consideration of other influences. For example, intoxication at the time of an event could lead to SDM or organic-induced memory impairment (Goodwin, 1995; Goodwin, Crane, & Guze, 1969; Goodwin, Powell

et al., 1969). Biopsychosocial moderating and mediating influences are, in fact, thought to impact the above patterns and are, therefore, expanded upon below.

Perspectives from a Biopsychosocial Model of Eyewitness Memory

Why does one eyewitness to a criminal event have a remarkable memory for his/her experience while another eyewitness to the same event develops dissociative amnesia? This question led us to develop a biopsychosocial model of eyewitness memory to assist in explaining eyewitness memory variability (see Hervé et al. 2007). A review of the literature indicates that the quality and quantity of crime-related memories are significantly influenced by an eyewitness' emotional response to the event, which reflects the interaction between characteristics of the eyewitness and of the event (Yuille & Daylen, 1998). In our view, emotional reactions reflect both physiological and psychological processes. It is proposed that eyewitness memory variability results from individual differences in both of these processes, differences stemming from specific and interacting biopsychosocial factors. As seen in Fig. 5.1 below, these factors are considered in terms of how they predispose an eyewitness to respond to an event (i.e., predisposing factors), how they affect an eyewitness during the event (i.e., precipitating factors), and how they affect the retention of the eyewitness' memory after the event (i.e., perpetuating factors). Although the entire biopsychosocial model is not outlined, examples of each of these factors are considered below.

Predisposing Factors

Predisposing factors concern the innate traits (e.g., personality characteristics) or prior experiences that influence how an eyewitness would typically respond to a criminal event (see Fig. 5.1). Theoretically, these factors lay the foundation for memory formation (Hervé et al. 2007). As illustrated below, we have divided predisposing (as well as precipitating and perpetuating) factors into biological, psychological, and social influences. This knowledge can be used to make predictions about the quality and quantity of memory that any given eyewitness should exhibit.

Biological Variables

Arousal sensitivity is a major factor mediating individuals' emotional responses to events of impact such as crimes/traumas (Blascovich, 1990, 1992; Feldman, 1995) and, as such, is a major factor accounting for individuals' memories for these experiences. Individuals vary in their sensitivity to arousal, with some individuals

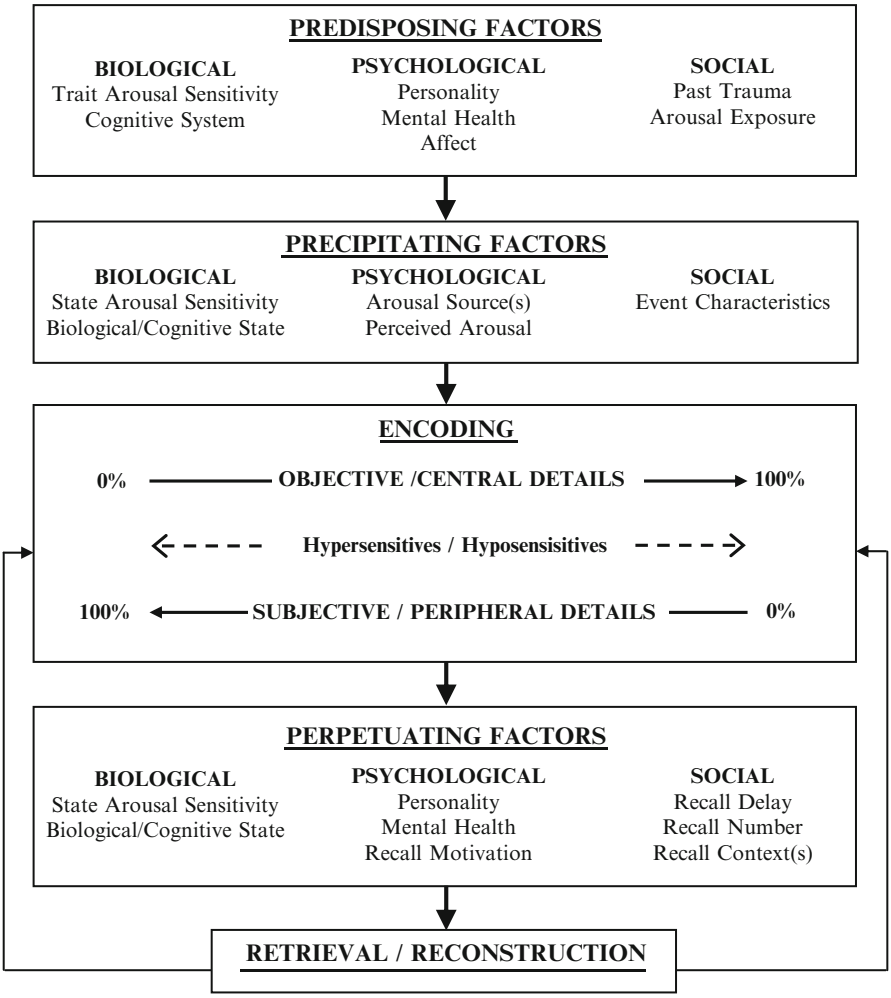

Fig. 5.1 A biopsychosocial model of eyewitness memory

focusing more strongly on autonomic arousal vs. their cognitive-interpretation of that arousal (Mandler, 1984). Arousal sensitivity can be viewed as a dimension, with hyposensitive individuals (i.e., those with low baseline levels of arousal such as psychopaths) and hypersensitive individuals (i.e., those with high baseline levels of arousal such as individuals with borderline personality disorder) defining the end points, and most individuals falling somewhere in between (see Fig. 5.2 below; Cooper, Hervé, & Yuille, 2007; Ellis, 1987).

It is thought that arousal sensitivity sets the threshold at which context-elicited arousal would be perceived as traumatic (e.g., high in arousal and extremely unpleasant). Table 5.1 (see below) provides a truncated illustration of how arousal affects

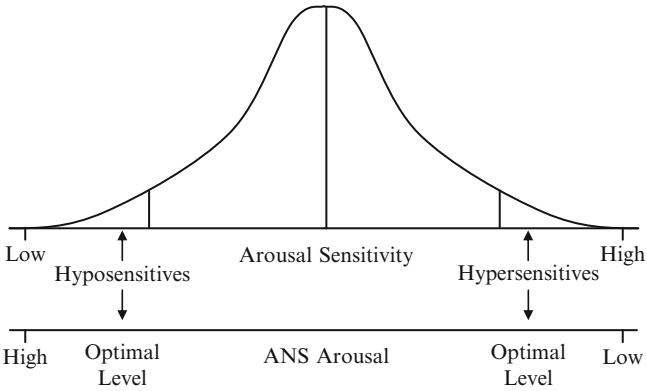

Fig. 5.2 Theoretical distribution of ANS arousal sensitivity and consequent optimal arousal levels

hyposensitive and hypersensitive individuals. As the Table suggests, hypersensitive individuals are likely to experience arousing events as traumatic at lower levels of arousal than would hyposensitive individuals (i.e., the same situation can lead to different levels of perceived arousal in different types of individuals). Although *trait* arousal sensitivity is theoretically resistant to long-term change, there are a number of factors that could affect arousal *state* sensitivity such as the level of threat an eyewitness is exposed to and/or acute substance abuse. These factors could functionally render individuals either hypersensitive or hyposensitive within a specific event.

The memory consequences of eyewitness' arousal sensitivity are multi-faceted. First, an eyewitness' sensitivity to arousal should dictate the point in time during arousal augmentation at which they would experience arousal-mediated attentional problems and, thus, memory distortions. As illustrated in Table 5.1, hypersensitive eyewitnesses should demonstrate memory distortions at an earlier point in time during arousal augmentation than hyposensitive individuals. Following this logic, during criminal/traumatic events, hypersensitive eyewitnesses are more likely than hyposensitive eyewitnesses to display serious memory distortions such as dissociative amnesia. Conversely, hyposensitive eyewitnesses are more likely than hypersensitive eyewitnesses to have vivid and detailed recollections of criminal/traumatic events (Cooper et al., 2007).

Second, individuals with different sensitivities to arousal should focus on different parts of an emotional event (Blascovich, 1990, 1992). Theoretically, hypersensitive eyewitnesses should focus more on their level of perceived arousal, while hyposensitive eyewitnesses should focus on their interpretation of such arousal and therefore on the emotion-evoking event (Mandler, 1984). Accordingly, during a criminal/traumatic event, hypersensitive eyewitnesses are likely to focus on internal (e.g., somesthetic) cues over external (e.g., environmental) cues and the opposite would transpire for hyposensitive eyewitnesses (see Fig. 5.3).

Table 5.1 Hypothetical arousal perception and arousal-mediated effects on attention, memory, and suggestibility based on trait arousal sensitivity and intensity of event-related arousal

Event-related arousal effects	Hypersensitive	Hyposensitive
Extremely low		
Perceived arousal	Very low/Uncomfortable	Extremely low/Intolerable
Attentional bias	External > Internal	External <<< Internal
External[a]	Central > Peripheral	Peripheral
Internal[b]	Cognitive > Sensory	Cognitive <<< Sensory
Memory distortions	RM/AF > NF/SM > DM(EF)/SDM (NF/SM)[d]	DM(IF)/SDM > RM/AF (NF/SM)[d]
Suggestibility[c]	Mild/Internal	Extreme/External
Very low		
Perceived arousal	Low/Comfortable	Extremely low/Distressing
Attentional bias	External = Internal	External « Internal
External[a]	Central = Peripheral	Central « Peripheral
Internal[b]	Cognitive = Sensory	Cognitive « Sensory
Memory distortions	NF/SM	RM/AF/DM(IF)/SDM (NF/SM)[d]
Suggestibility[c]	None[e]	Moderate/External
Low		
Perceived arousal	Medium/Optimal	Very low/Uncomfortable
Attentional bias	External ≤ Internal	External < Internal
External[a]	Central ≤ Peripheral	Central < Peripheral
Internal[b]	Cognitive < Sensory	Cognitive < Sensory
Memory distortions	RM/NF/SM	RM/AF > NF/SM > DM(IF)/SDM (NF/SM)[d]
Suggestibility[c]	Mild/External	Mild/External
Medium		
Arousal perception	High/Uncomfortable	Low/Comfortable
Attentional bias	External < Internal	External = Internal
External[a]	Central < Peripheral	Central = Peripheral
Internal[b]	Cognitive « Sensory	Cognitive = Sensory
Memory distortions	RM/AF > NF/SM > DM(IF)/SDM (NF/SM)[d]	NF/SM
Suggestibility[c]	Moderate/External	None[e]
High		
Perceived arousal	Very high/Traumatic	Medium/Optimal
Attentional bias	External « Internal	External ≥ Internal
External[a]	Central « Peripheral	Central ≥ Peripheral
Internal[b]	Cognitive <<< Sensory	Cognitive > Sensory
Memory distortions	RM/AF/DM(IF)/SDM(RO) (NF/SM)[d]	RM/NF/SM
Suggestibility[c]	High/External	Mild/Internal
Very high		
Perceived arousal	Extremely high/Unbearable	High/Uncomfortable
Attentional bias	External <<< Internal	External > Internal
External[a]	Peripheral	Central > Peripheral

(continued)

Table 5.1 (continued)

Event-related arousal effects	Hypersensitive	Hyposensitive
Internal[b]	Cognitive <<< Sensory	Cognitive » Sensory
Memory distortions	DM(IF)/SDM(RO) > RM/AF (NF/SM)[d]	RM/AF > NF/SM > DM(EF)/ SDM (NF/SM)[d]
Suggestibility[c] Extremely high	Extreme/External	Moderate/Internal
Perceived arousal	Extremely high/Debilitating	Very high to extremely high/ Traumatic to Debilitating
Attentional bias	Internal	External » Internal to Internal
External[a]	N/A	Central » Peripheral to Central
Internal[b]	Sensory	Cognitive >>> Sensory to Sensory
Memory distortions	DA	DM(EF)/SDM(RO) ≥ RM/AF (NF/SM)[d] to DA
Suggestibility[c]	Extreme/External	High to Extreme/Internal to External

NF normal forgetting; *AF* active forgetting; *DA* dissociative amnesia; RM remarkable memory; SDM state-dependent memory; *RO* red out; *SM* script memory; DM dissociative memory

[a]Central and peripheral information objectively defined

[b]Cognitive and sensory information of environmentally elicited affective response

[c]Refers to both susceptibility level and type, the latter stemming from attentional bias—created memory not specified as reflects post encoding psychosocial factors

[d]Occurs only if individual, due to personal history, habituated to event

[e]While increasingly likely over time, suggestibility not provided as reflects state more than trait effects

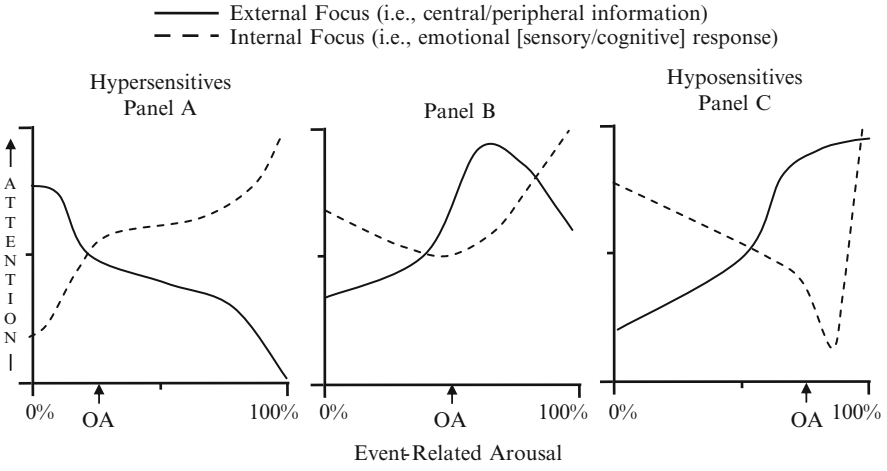

Fig. 5.3 Theorized orientation response (external vs. internal attentional focus) based on event-related arousal and arousal sensitivity (OA = optimal arousal)

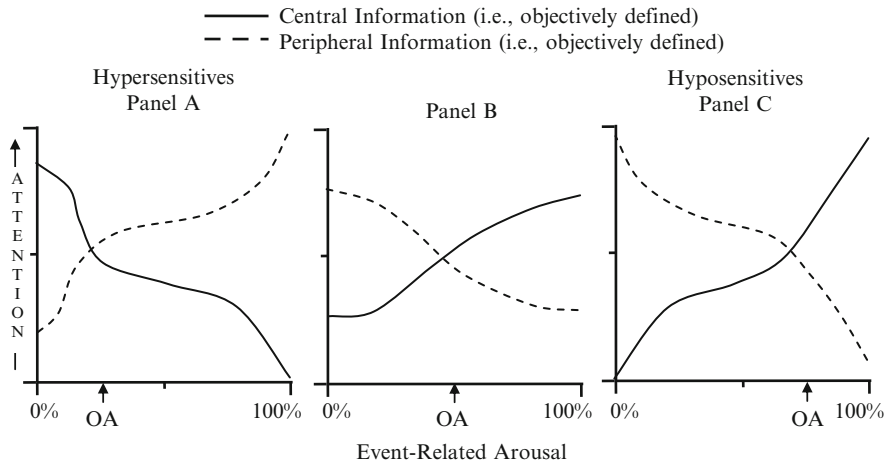

Fig. 5.4 Theorized external orientation response (central vs. peripheral attentional focus) based on event-related arousal and arousal sensitivity (*OA* optimal arousal)

Consistent with the above theoretical speculations, it has been shown that individuals have a tendency to be either emotion-focused (e.g., pleasure-focused) or arousal-focused when evaluating either their own emotional reactions, with the former having an affective response strongly based on the interpretation of the emotional event itself and the latter having an affective response strongly based on their reactions to an emotional event (Feldman, 1995). Taken together, one would expect hyposensitive eyewitnesses to have more cognitively based memories (e.g., autobiographical/narrative) and hypersensitive eyewitnesses to have more physiologically based (i.e., emotional-sensory) memories for criminal/traumatic events (Hervé et al. 2007). With augmentations in perceived arousal, hypersensitive eyewitnesses—who are likely to view moderate-to-intense arousal as aversive—should increasingly focus internally while concurrently avoiding the arousal-eliciting source (see Table 5.1 and Fig. 5.3). Any attention focused externally is likely geared towards decreasing the intensity of the situation (e.g., by locating an escape route). This reaction is consistent to a phobic individual who, although peripherally aware of a phobic stimuli (e.g., an insect), searches for a way to escape the situation in order to decrease his/her anxiety (Thorpe & Salkovskis, 1998). In contrast to hypersensitive eyewitnesses, arousal augmentations in hyposensitive eyewitnesses should lead them to increasingly focus externally on the arousal-eliciting source and away from their internal states (see Table 5.1 and Fig. 5.3). This reaction is akin to that of experienced law enforcement personnel who, for example, although vaguely aware of his/her internal state during an armed stand-off, primarily focuses his/her attention on the perpetrator. Consequently, hyposensitive individuals should generally make better eyewitnesses than hypersensitive individuals (Cooper et al., 2007). Relative to the latter, the former are likely to recall information that is crucial to the investigative process (i.e., who did what to who; see Fig. 5.4).

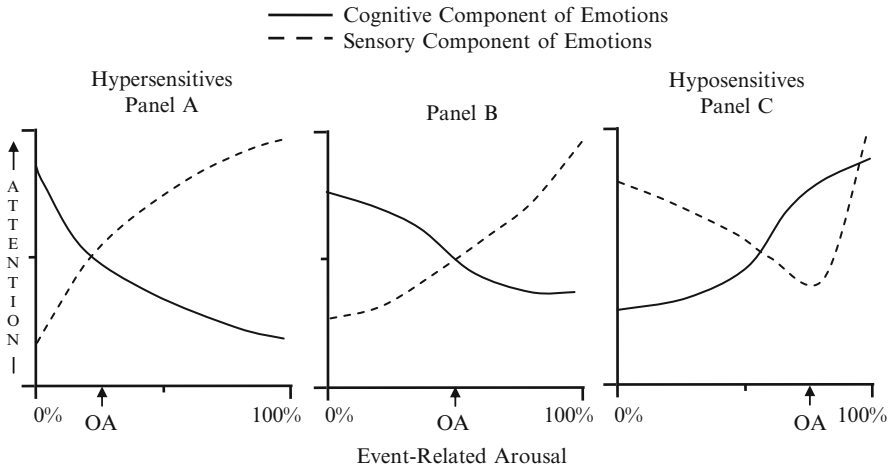

Fig. 5.5 Theorized internal orientation response (cognitive vs. sensory attentional focus) based on event-related arousal and arousal sensitivity (*OA* optimal arousal)

The above differences between hyposensitive and hypersensitive eyewitnesses notwithstanding, intense levels of arousal are likely to result in a potent ANS reaction irrespective of an individual's trait arousal sensitivity. Thus, at such high intensity levels, all eyewitnesses are likely to recall, at least in part, their sensory experiences (see Fig. 5.5). That is, arousal intensity should be strongly associated with somesthetic memories, albeit more strongly so with hypersensitive eyewitnesses than hyposensitive eyewitnesses. In support of this view, van der Kolk and Fisler (1995) provided examples of patients who could recall their emotions related to their traumatic experience without remembering the actual experiences. For example, they discussed a victim of sexual assault who became agitated when brought back to the scene of her attack without an explicit recollection of the actual sexual assault.

Given its impact on orientation/attention, memory processes and motivation (e.g., fight vs. flight), arousal sensitivity is proposed to be the single most important individual difference factor influencing eyewitness memory. Indeed, the majority of the mediating/moderating variables reviewed below are likely to exert effects on memory either upon or as a result of one's trait arousal sensitivity.

As with arousal sensitivity, neurocognitive functioning is an innate characteristic with implications for memory formation. Not only will neurocognitive functioning impact the emotional processing of an eyewitness by delineating the meaning analysis of the criminal/traumatic event, but it may also separately impact the stages of memory. For example, attentional and working memory functioning are likely to impact encoding quantity; and spatial and language functioning are likely to impact encoding quality. Memory functioning and processing speed should impact storage, and executive and language functioning should impact the quantity and quality of retrieval (Hervé et al. 2007). Impairments in any of these neurocognitive domains,

coupled with ANS stimulation in the context of witnessing a crime, may disrupt mental processing. Therefore, understanding an eyewitness' neurocognitive strengths and weaknesses, is crucial to the understanding of the eyewitness' memory capabilities. Indeed, neurocognitively impaired eyewitnesses have been found to recall memories with less quantity in comparison to those without neurocognitive deficits (Ternes & Yuille, 2008).

Psychological Variables

Psychologically, emotions are regulated by a cognitive interpretative system. As reviewed above, while arousal sensitivity guides attention, the cognitive system primarily interprets the attended-to information and, therefore, sets the quality of emotional/traumatic events such as crimes. Throughout development, individuals learn to emotionally differentiate objects, situations, and people (Mandler, 1984). New emotional events are then interpreted in light of both their current characteristics (e.g., valence, threat, duration, type) and one's lifelong emotional learning history (e.g., current interpretations reflect, in part, the sum of past interpretations of similar events). Given the developmental nature of this system, mental ability (e.g., neurocognitive impairments/strengths), personality, specific traits (e.g., arousal sensitivity, cognitive distortions), and more transient psychological factors (e.g., Axis I disorders, substance use) are thought to exert an influence. These factors are believed to add unique, idiosyncratic cognitive filters through which events are interpreted, as well as to expose different individuals to different emotional events, thereby setting the parameters of one's emotional learning environments/history. For example, hypersensitive eyewitnesses, who are emotionally motivated to avoid arousal, are likely to be quick to label events as either good (e.g., low arousing) or bad (e.g., high arousing)—that is, along a valence dimension. In contrast, hyposensitive eyewitnesses, who seek out and focus upon arousing events, are likely to interpret events as either arousing or not—that is, along an arousal continuum. These labels should then be reflected within eyewitnesses' statements. For example, a hyposensitive bystander, when asked to describe how he felt when witnessing an assault, is likely to report how energized and excited the event made him/her feel. In contrast, a hypersensitive bystander faced with the same situation may report how scared s/he was and describe the incident as "awful."

Personality is another predisposing psychological factor that should be considered in eyewitness research and practice, especially given its theoretical connection to arousal sensitivity (Deffenbacher, Bornstein, Penrod, & McGorty, 2004; Ellis, 1987; Eysenck, 1967; Hervé & Hare, 1998). Indeed, personality delineates what information is encoded (e.g., Christianson et al., 1996) and mediates post-encoding distortions (e.g., Porter et al., 1999, 2000). Moreover, an individual's meaning analysis of a particular event will be affected, in part, by an individual's personality (e.g., Blair et al., 1995). In terms of non-pathological personalities, introverted individuals are likely to be more sensitive to traumatic/criminal experiences than are

extroverted individuals, as the former are more sensitive to arousal than the latter (Zuckerman, 1979). As such, the introverted eyewitness is likely to feel more threatened under stress than the extrovert, a factor that is likely to affect the quantity and quality of his/her eyewitness memory (see Bothwell, Brigham, & Pigott, 1987 regarding the memory performance of "neurotics" vs. "stables"). Indeed, although both the introverted eyewitness and the extroverted eyewitness may recall a specific crime as arousing, the introvert is likely to recall it as more unpleasant than the extrovert, a point that has obvious memory consequences. It should be noted that these personality-related differences are likely exaggerated when considering pathological personalities, personalities that are frequently encountered within the forensic arena in which eyewitness researchers and clinicians practice (Christianson et al., 1996). For example, the psychopath, who is theoretically the most arousal hyposensitive of all eyewitnesses (Blackburn, 1979; Hare, 1965; Hervé & Hare, 1998), is likely to feel little traumatic arousal. Preliminary research suggests that psychopaths have better memories than nonpsychopaths arguably due to differences in arousal sensitivity (Cooper et al., 2007).

An individual's psychiatric history is also a predisposing eyewitness memory factor. Indeed, psychiatric problems are likely to affect eyewitness' arousal sensitivity and their interpretative abilities. For example, eyewitnesses with anxiety disorders are likely to be highly sensitive to arousal fluctuations during events of impact. That is, some Axis I disorders may serve to delineate the intensity of emotional responses during crimes, a point with important memory implications (Hervé et al. 2007). Unfortunately, little is known regarding the influence of Axis I disorders on eyewitness memory, a point in need of research. In addition to helping expand our knowledge regarding the processes affecting memory, such information could also be used as an index of arousal sensitivity (e.g., one would expect anxiety disorders to be over-represented in hypersensitive eyewitnesses).

Social Variables

In addition to biological and psychological factors, a variety of predisposing social variables could impact eyewitness memory. Although arousal sensitivity, viewed as a trait, is by definition, resistant to change, it can theoretically alter due to experience (Mandler, 1984). Indeed, an eyewitness' history of victimization may affect his/her state arousal sensitivity for similar future events via sensitization. That is, past experiences with trauma/crime may have important consequences in terms of how future traumas/crimes are experienced and remembered (Porter, 1996; Terr, 1991; van der Kolk, van der Hart, & Marmar, 1996).

The direction of the sensitization (e.g., negative vs. positive) depends on the type of events previously experienced. One the one hand, the experience of past crimes of a traumatic nature (e.g., events that are highly arousing and unpleasant) may sensitize eyewitnesses in such a manner that future crimes are experienced as relatively more disturbing. This view is reflected, in part, in the symptom formulation of PTSD

(APA, 2000). A defining feature of PTSD is hyperarousal/hypervigilance (van der Kolk, 1997), a symptom consistently reported by veterans and victims of crime (Cooper et al., 2004; Darves-Bornoz, 1997; Darves-Bornoz et al., 1998; Griesel & Yuille, 2012; O'Toole, Marshall, Schureck, & Dobson, 1999; Op den Velde et al., 1996). The end result is that such individuals, when faced with subsequent crimes/traumas, can functionally become hypersensitive eyewitnesses, irrespective of their trait arousal sensitivity. However, this effect may dissipate if the experienced event, although objectively of high intensity, is subjectively experienced as relatively benign (i.e., as compared to the intensity of the previous crime/trauma).

On the other hand, past experiences with highly arousing, but non-traumatic situations are likely to desensitize eyewitnesses to the effects of arousal. That is, a history of experiencing non-traumatic arousal may decrease an eyewitness' arousal sensitivity for future events (i.e., creating a state of hyposensitivity). For example, an individual who regularly participates in extreme sports (e.g., sky diving, cliff jumping) and/or is an avid consumer of arousal inducing intoxicants (e.g., amphetamines) may habituate to the effects of arousal over time. At the very least, they are likely to label the arousal inducing event as more positive in valence than someone who has not habituated (Bockheler, 1995). Such cognitive interpretations of emotional events are important, as perceptions of valence have been shown to affect eyewitness memory, independent of perceptions of arousal (Cooper, 2005).

Precipitating Factors

Precipitating factors concern variables at play during the to-be-remembered event and include the type of event itself (e.g., event of impact/personal significance vs. mundane event). As Fig. 5.1 suggests, the effects of precipitating factors are influenced by the foundation laid by predisposing factors (Hervé et al. 2007).

Biological Variables

In terms of physiological arousal, emotional reactions should, in part, delineate the content of eyewitness memory. Arousal physiologically prepares the eyewitness to deal with the event (e.g., flight, fight or freeze). Obviously, a victim of a crime who fights will have different recollections than a victim who freezes or flees the scene. Theoretically, this response is likely mediated by arousal sensitivity. While the hypersensitive eyewitness is likely to become extremely uncomfortable by crime-induced arousal, the hyposensitive eyewitness is less likely to be affected by such stimulation; in certain cases, the hyposensitive eyewitness may even enjoy the situation or at least perceive it as less negative (Cooper, 2005). For example, consider how individuals respond to a sky diving experience: the hypersensitive sky diver is likely to feel highly aroused and terrified while the hyposensitive is

likely to feel aroused and excited. Of course, this effect may be mediated by variables that affect one's state sensitivity such as substance use (e.g., alcohol and amphetamines have dampening and stimulating ANS effects, respectively) and experience (e.g., novice vs. experienced sky diver; see Bockheler, 1995). Clearly, this distinction has important behavioral consequences and, therefore, memory consequences. While the hypersensitive eyewitness is likely to seek a quick escape (i.e., a flight response) from a crime, the hyposensitive eyewitness, in his/her search for stimulation, is likely to confront the situation (i.e., fight response) and focus his/her attention on the event proper. The hypersensitive eyewitness' memory is likely to contain, in addition to significant somesthetic information, a greater amount of peripheral information, reflecting a flight response (e.g., a focus on an escape route and possible obstacles; a focus on bystanders and their reactions), than central information (e.g., a focus on the perpetrator and his/her actions). In contrast, the hyposensitive eyewitness' memory may reflect his/her strong focus on the situation at hand and, therefore, will likely contain a great deal of both peripheral (e.g., the fight response and objects that may facilitate such a response) and central information (e.g., perpetrator, accomplice and weapon information). Accordingly, researchers/investigators are urged to consider how high levels of arousal and arousal sensitivity interact when examining the effects of stress/crime on eyewitness memory. It is suggested that investigative interviews primarily use open-ended questions and examine what the eyewitness focused on during the crime (see Yarbrough et al., present volume).

All variables considered equal, criminal events should cue an ANS response that guides the eyewitness' attention towards the source of the arousal. As such, the source of the arousal should be given priority over arousal-irrelevant information in the processing stream, thereby resulting in greater memory for arousal-relevant, as compared to arousal-irrelevant information. In support of this hypothesis, research has found emotional stress to evoke an orientating response, where the emotional event is allocated the most attention in a quick and efficient fashion (Burke, Heuer, & Reisberg, 1992; Christianson & Loftus, 1990; Deffenbacher et al., 2004). For example, Christianson and Loftus (1991) had participants view slides of either neutral or emotionally unpleasant events and showed that participants remembered more of the central details, as opposed to peripheral details, when the slides were emotionally laden. Others have found that central information, both spatially and temporally, is remembered better than peripheral information, and that theme-related information is better remembered than theme-unrelated information (e.g., Safer, Christianson, Autry, & Osterland, 1998; see Christianson, 1992, for a review). This attention-related effect is also found in the eyewitness literature that has utilized archival and field methods, thus helping to bridge the gap between laboratory and field studies. For example, Christianson and Hubinette (1993) examined witness' and victims' memories of post office robberies and found that the recollections concerning the robbery's central details (e.g., regarding action, weapon, and clothing details) were more consistent with police reports than their recollection of peripheral information (e.g., regarding the date, time, and descriptions of other people). Similarly, mock witnesses exposed to simulated crimes in which a weapon was

involved have been found to quite clearly remember details regarding the weapon used, while having poorer memories for other details, such as the hair colour, height, or clothes of the mock assailant (e.g., Kramer, Buckhout, & Eugenio, 1990; Loftus, Loftus, & Messo, 1987; O'Rourke, Penrod, Cutler, & Stuve, 1989; Pickel, 1998, 1999; note, however, that this analogue weapon focus has not been conclusively demonstrated with actual eyewitnesses—see Behrman & Davey, 2001; Cooper, Kennedy, Hervé, & Yuille, 2002; Griesel & Yuille, 2012; Tollestrup et al., 1994; Valentine, Pickering, & Darling, 2003). Thus, the arousal elicited by certain events, irrespective of its intensity, has the effect of narrowing one's attention on the central details of the scene as Easterbrook's (1959) theory suggests. These arousal-mediated attention effects seem adaptive. Indeed, quickly changing one's attention from a relatively neutral act (e.g., feeding) to an emotionally laden one (e.g., the presence of a predator) or from irrelevant (e.g., the price of fruit) to relevant (e.g., the sight of a gun) information has obvious survival value.

Psychological Variables

While arousal sensitivity and other genetic/biological factors may delineate what information is allocated attentional resources during a criminal event, evaluative cognitions define the quality of the event. As such, to understand memory for crime, one should be knowledgeable about how cognitive styles and distortions affect thoughts and memories. Although several different evaluative dimensions have been suggested (e.g., Larsen & Diener, 1992; Watson, Clark, & Tellegen, 1988), valence and arousal (i.e., defined cognitively, not biologically) have received the most empirical support across age groups, cultures, and gender (Bradley & Greenwald, 1992; Russell, 1989; Russell & Bullock, 1985, 1986; Smith & Ellsworth, 1985). Given this consistency, Russell (1980) noted that, although both components are necessary for an emotional evaluation, neither alone is sufficient (also see Mandler, 1984). As suggested above, individuals differ in regards to how much weight they place on one dimension over another (Blascovich, 1990, 1992; Feldman, 1995), with hypersensitive individuals and hyposensitive individuals being more concerned with valence and arousal, respectively (see Fig. 5.5). These emotive cognitive differences, in turn, are then likely to be reflected in the quality of memory, with the recall of hypersensitive eyewitness reflecting valence over arousal and the recall of hyposensitive eyewitnesses showing the opposite pattern.

In addition to emotive variability in cognitive processing, a number of psychological and predisposing processes (see above) are known to influence cognition, each of which may help to explain the variable nature of eyewitness memory. As noted by Mandler (1984), while the pre-programmed ANS reactions are resistant to change, the cognitively based reactions, being rooted in one's autobiographical past, are likely to be highly idiosyncratic and dynamic. These reactions, or evaluative cognitions, mirror a learned response. They become associated with emotional/criminal events via classical conditioning, thereby turning the neutral into the emotional. There are, for example, objects (e.g., a gun) and events (e.g., banking) that are

initially neutral in connotation but may become—through classical conditioning—actual ANS releasers. Such classical conditioning, in turn, is dependent on the types of events experienced, as well as on the fashion in which these experiences are evaluated—both of which are dependent, in part, on personality and mental health. An in-depth psychological profile of eyewitnesses/interviewees could therefore help shed some light on these apparent idiosyncratic responses (see Yarbrough et al., present volume). As noted above, introverted and extroverted individuals are likely to seek out different types of events and, hence, experience different conditioning paradigms. Similarly, the cognitive distortions of schizophrenics, as an example, are likely to result in memory distortions unlike any seen in non-schizophrenics. Accordingly, it is suggested that laboratory models of memory for trauma/crime would gain external validity by using trauma/crime-specific stimuli (i.e., specific to the participant at hand), rather than general threat stimuli (e.g., Clifford & Hollin, 1981), a method effectively used in the study of anxiety disorders and memory (see Radomsky & Rachman, 1999, 2001; Radomsky, Rachman, & Hammond, 2001).

Another precipitating psychological variable is the type of event the eyewitness experiences (e.g., whether the eyewitness interprets the event as stressful, irrespective of the "objective" nature of the event). In fact, the study of this issue has been the subject of a large amount of research attention, although researchers have often confounded event type with event interpretation. Researchers have examined the effects of event type on eyewitness memory in analogue laboratory research by exposing mock eyewitnesses to different levels of stress or arousal or by varying the type of event they view (e.g., violent vs. nonviolent; stressful vs. non-stressful), typically via slides or videos and less commonly through staged events. Early research on this topic led to the conclusion that high levels of stress/arousal had debilitating effects on eyewitness memory (see Deffenbacher, 1983; also see Deffenbacher et al., 2004). Seemingly at odds with the results of laboratory research are the results of field studies of actual eyewitnesses which demonstrated that eyewitnesses can be detailed and accurate in their accounts of events experienced under high stress (Cutshall & Yuille, 1989; Yuille & Cutshall, 1986). In attempt to explain these divergent findings, Christianson (1992), via a critical review of the literature, showed that the effects of stress/arousal on memory is complex and depends on a number of variables (e.g., what dependent variables researchers examine and highlight—e.g., central vs. peripheral details). Indeed, as the above review of memory patterns suggests, stress/arousal has complex effects on eyewitness memory with some witnesses displaying good memory and other eyewitnesses displaying poor memory (Yuille & Daylen, 1998).

An excellent example of the complex effects of arousal/stress on memory is the results of the study by Morgan et al. (2004). The researchers capitalized on a US military survival school where the participants, mock prisoners of war (POW), were sleep and food deprived before being faced with "interrogation stress." All participants were subjected to both high and low interrogation stress conditions which encompassed being interrogated for 40 min by an interrogator in the presence of a guard—the only difference between the conditions concerned the presence of "physical confrontation" by the guard in the high stress condition.

Twenty-four hours after their mock interrogations, the participants were asked to identify their interrogator from a lineup or photospread. The results indicated that 42–50% of the participants performed better in their mock eyewitness identifications in the low stress condition in comparison to the high stress condition. Results such as these have led many to argue that high levels of stress negatively impact eyewitness memory (e.g., Deffenbacher et al., 2004) and that eyewitness are prone to make identification errors (e.g., Loftus, 2012). What should be highlighted, however, is that 42–45% of the participants performed equally poorly or equally well across the stress conditions, and that 8–13% of the participants actually performed better in the high stress condition in comparison to the low stress condition. That is, the results confirm that stress/arousal has complex effects on memory: some participants performed better under conditions of low stress and some participants performed better under conditions of high stress. It is possible that biopsychosocial factors (e.g., arousal sensitivity), independent of the type of event, can, in part, account for these findings. Indeed, it may be the case that the participants who performed better in the low stress than high stress condition were relatively hypersensitive to arousal and those participants who performed better in the high stress condition than the low stress condition were relatively hyposensitive to arousal (Morgan, personal communication, February, 2011). Clearly, future research that assesses for such individual difference variables in the context of multi-method approaches (e.g., laboratory, archival, field) is needed to assist in disentangling the complex effects of the type of event (e.g., high stress vs. low stress) experienced on eyewitness memory (Hervé et al. 2007; Yuille, 1993; Yuille et al., 2010).

Social Variables

In addition to precipitating biological and psychological factors, precipitating social variables are thought to influence eyewitness memory. The context at encoding, for example, is likely to impact eyewitness memory as it should delineate the intensity and quality of the accompanying affective response and assist in defining the subjective meaning ascribed to events. As noted above, an emotional response encompasses both physiological and cognitive components, and the relative contribution of each response to the overall emotional experience is likely to depend, at least in part, on the nature of the situation (e.g., a laboratory vs. a field setting). On the one hand, most laboratory studies and other neutral settings are not likely to present mock witnesses with highly arousing situations, forcing participants to evaluate yet not experience emotional material. On the other hand, emotional settings, such as those seen in field research, represent highly arousing contexts that are generally evaluated and experienced as emotional in nature (Yuille, present volume). Thus, while the quality attached to memories of videos and slides (e.g., as seen in laboratory paradigms) reflect only cognitive processes, the quality attached to memories of criminal events (e.g., as seen in field research) reflects both ANS and cognitive

functions, suggesting that the quality of memories for benign as opposed to significant events differ, at the very least, in degree (Hervé et al. 2007).

Context also affects the meaning assigned to particular events. For example, in terms of personal safety, some research has found victims and injured victims to report less crime-related information than witnesses and non-injured victims, respectively (e.g., Christianson & Hubinette, 1993; Kuehn, 1974). This suggests that the level of personal involvement within a criminal event can have significant effects on eyewitness memory. Distinguishing between emotional events that are life threatening (i.e., with personal consequences) and those that are not (i.e., without personal consequences) is thus encouraged in future research. It seems logical to predict that highly arousing events which place eyewitnesses in dangerous positions (e.g., being a victim) would evoke deeper and more personal sensations/cognitions than those that, although highly arousing, do not suggest imminent danger (e.g., witnessing a crime from across the street). The field would benefit from understanding the memory consequences of these different situations.

Perpetuating Factors

Perpetuating factors concern variables that effect memory after it has been formed. Considering the reconstructive nature of memory, eyewitness memory is susceptible to influences each time it is recalled (e.g., in thoughts, conversations, interviews).

Biological Variables

In addition to playing a role as both a predisposing and a precipitating factor, arousal sensitivity is also a significant perpetuating factor in light of its impact on decay (Hervé et al. 2007). Decay refers to the natural memory process of time-based forgetting, a process that usually occurs when memories are not given any subsequent attention (i.e., not recalled). Research indicates that certain memories are more resistant to decay than others, with affectively benign memories decaying at a faster rate than affectively loaded memories (Christianson, 1989; Cutshall & Yuille, 1989; Thompson et al., 1997; Yuille & Cutshall, 1986). Such findings highlight the central role of affect in decay, suggesting that arousal sensitivity, given its impact on emotions, should also influence decay. Specifically, one's arousal sensitivity (with all other variables being equal) should delineate the intensity of the affective load attached to memory, with hypersensitive eyewitnesses having a greater affective load attached to their memories for criminal events than hyposensitive eyewitnesses. Consequently, one would expect the memories of hyposensitive eyewitnesses to be more resistant to decay than the memories of hypersensitive eyewitnesses. However, this effect should not be considered in isolation, especially since hypersensitive and hyposensitive eyewitnesses are likely to differ in terms of how motivated they are to

recall such events. As hypersensitive and hyposensitive individuals differ in behavioral motivation (Ellis, 1987), with the former motivated to avoid and the latter to seek out arousing situations, it follows that hypersensitive eyewitnesses are relatively more likely to avoid thinking about their past criminal experiences and hyposensitive eyewitnesses are relatively more likely to actively seek out an audience to share their memories. Thus, recall-related memory decay should be facilitated in hypersensitive eyewitnesses and impeded in hyposensitive eyewitnesses.

The above notwithstanding, repeated recall should have different effects on the memories of hypersensitive vs. hyposensitive eyewitnesses. On the one hand, hypersensitive eyewitnesses, given their internal affective focus, will, theoretically, focus their thoughts on what transpired within their own systems during their past criminal experience. As such, repeated recall should strengthen their memory trace for crime-related sensory information leaving, however, event-related information vulnerable to decay (Hervé et al. 2007). On the other hand, hyposensitive eyewitnesses, given their external affective focus, will, in theory, focus their thoughts on the event proper. Therefore, repeated recall should strengthen their memory trace for event-related information, with decay affecting subjective information.

Psychological Variables

As perpetuating factors, psychological variables are likely to exert their memory impact on when, why, and how recall occurs (Hervé et al. 2007). For example, eyewitnesses may be motivated to distort their memories of their criminal experiences for a variety of reasons. Indeed, a sexual assault victim may consciously leave out some aspect(s) of his/her experience when telling his/her partner. Others might consciously distort their experiences to either ensure that they are taken seriously or as a form of retaliation against the perpetrator, as seen when victims/witnesses exaggerate their memories. Unfortunately, such distortions, given the reconstructive nature of memory, may become memory reality (i.e., historical vs. narrative truth; Hyman & Loftus, 1997; Nash, 1994), thereby distorting the veracity of the eyewitness account upon further recall.

In addition to motivation, there are other psychological variables that may intervene between encoding and recall that may affect one's memory for traumatic/criminal events. For example, traumatized individuals need to make sense of their experience, recalling and reconstructing the event as they see fit until they can safely integrate it within their own worldview. This process is related, in part, to one's personality makeup and, depending on the specific personality, different memory distortions may therefore emerge. Given the impact that affect has upon memory, affective state/reactions during recall should also delineate the quality and quantity of eyewitness memories. As noted above, one's dominant affective style will affect what type of information is given the most attention, irrespective if this occurs at encoding or at recall. In addition, affect can also serve as a memory cue, as seen in mood-dependent research (see above). Finally, affect, with its influence on ANS

arousal, has a host of influences on cognitive mechanisms (see above), each of which has predictable memory consequences.

As suggested above, the development of PTSD may also impact eyewitness memory. Intrusions of the precipitating event of impact (Horowitz, Wilner, & Alvarez, 1979), in combination with arousal sensitivity, may be responsible for the phenomena of hypernesia (i.e., better than normal memory; Scrivner & Safer, 1988). Repeated recollections of crimes in the form of flashbacks and/or nightmares are typically accompanied by significant physiological arousal (APA, 2000). In the hypersensitive eyewitness, such added arousal may be overwhelming. As a result, the individual may actively try to forget the experience (i.e., push the memory out of mind whenever it arises) and avoid anything that may remind him/her of the event (another feature of PTSD). Active forgetting may be successful in reducing the amount of unpleasant details available to memory and, in its extreme, may lead to dissociative amnesia. With a hyposensitive eyewitness, the added arousal, while likely unpleasant given its negative source (i.e., past crime), might never become unbearable. As such, every recollection may be accompanied with a manageable level of arousal that could serve to enhance memory and, therefore, progressively leads to hypernesia (Scrivner & Safer, 1988) or a remarkable memory (Yuille & Daylen, 1998).

Social Variables

The recall context will impact what type of information is sought from eyewitnesses and, therefore, what is recalled upon retrieval. For example, investigative interviews, in which the motivation is to elicit an account of an alleged crime (see Walsh & Bull, present volume; Yuille, Marxsen, & Cooper, 1999), are likely to be focused primarily on event-related information (see Yarbrough et al., present volume). In contrast, while some overlap exists, therapeutic encounters, in which the motivation is successful treatment, are likely equally focused on event- and sensory-related information, if not more so on the latter than the former. A consequence is that each type of context likely solidifies different types of memories, leaving other memories vulnerable to the effects of decay and/or suggestibility.

The manner in which the information is elicited from eyewitnesses should also be considered. For example, a substantial body of research highlights the negative impact of leading/suggestive questions/interviews on eyewitness memory (see Bruck, Ceci, & Hembrooke, 1998; Ceci & Bruck, 1993; Hyman & Loftus, 1997; Memon, Holley, Wark, Bull, & Kohnken, 1996; Wells & Turtle, 1987). In addition to jeopardizing criminal investigations, leading questions/interviews can facilitate memory distortions. Indeed, several investigators have been able to implant false trauma-like memories (Loftus, 2012; Loftus & Pickrell, 1995; Porter et al., 1999), highlighting the malleable nature of memory. Leading questions/interviews may lead to memory distortions, which may subsequently be perceived as reality (Nash, 1994), spoiling memory accuracy.

Social factors could also impact eyewitnesses when faced with making identifications at lineups (Wells et al., 1998). Laboratory researchers have suggested that non-blind lineup administrators could unknowingly cue the eyewitness as to the police suspect's position in the lineup (Dysart, Lawson, & Rainey, 2011), possibly leading to false identifications. Further, laboratory research has examined the post-identification feedback effect, the results of which suggest that confirming or disconfirming feedback by mock lineup administrators can distort mock eyewitness' confidence ratings of their identifications (Douglass & Steblay, 2006; Semmler, Brewer, & Wells, 2004; Wells, Olson, & Charman, 2003). These and other lineup effects, however, have not been sufficiently tested in real world settings (but see Wright & Skagerberg, 2007), suggesting caution in their interpretation and applicability to actual eyewitnesses (Yuille, present volume; Yuille & Cooper, 2012; Yuille et al., 2010). Indeed, it has been shown that effects found in the laboratory may not translate to the field—in fact, sometimes, the effects found in the real world are opposite to those found in the laboratory (Mitchell, 2012). Nevertheless, if lineup effects are sufficiently tested in archival and field studies and if the results conform to the results of controlled laboratory experiments, some of the findings may be impacted by issues concerning suggestibility (e.g., a biased lineup or a suggestive lineup administrator could arguably be akin to a suggestive interview—with negative recognition and recall consequences, respectively).

The type of information an eyewitness is suggestible to may depend on his/her arousal sensitivity. Take the extreme example of dissociation—dissociative experiences are likely to disrupt the encoding of event-related information in hypersensitive eyewitnesses and of sensory-related information in hyposensitive eyewitnesses. Accordingly, while the hypersensitive eyewitness, given his/her access to sensory information, would be suggestible to event-related information, the hyposensitive eyewitness, given his/her relatively intact event-related information, is more likely to be suggestible to sensory- than to event-related information. Consequently, interviewers should be aware of the possibility that interviewees may not have access to "everything" that transpired during their criminal experiences, a point with important practical implications (see Yarbrough et al., present volume). For example, eyewitnesses without a complete narrative of their experience may, in attempts to make sense of what happened to them or others, latch on to the "explanations" given to them. That is, such individuals are likely to be very suggestible, which, if not paid attention to, could lead to serious memory distortions (Yuille & Daylen, 1998).

Biopsychosocial Predictions of Eyewitness Memory Variability

The aforementioned review suggests that the memory variability reported within and across the eyewitness memory literature stems from a host of predisposing, precipitating, and perpetuating individual differences variables that impact a multidimensional affective response that influence each stage of memory (see Fig. 5.1). At the encoding/storage stages, the type, quality, and quantity of an eyewitness'

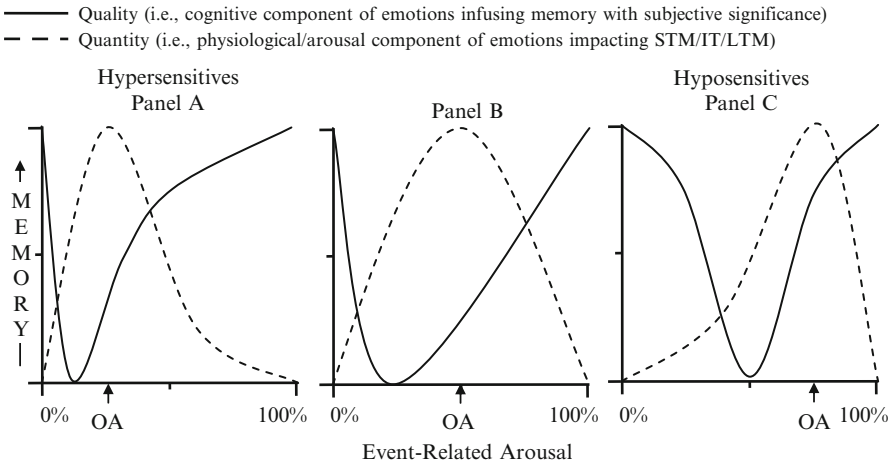

Fig. 5.6 The theorized relationship between memory (quality and quantity) and emotions based on a multidimensional model of emotions (cognitive and physiological components), event-related arousal, and arousal sensitivity (*OA* optimal arousal)

memory should be highly dependent on his/her emotional state (see Fig. 5.6). Initially, criminal events should initiate an ANS arousal response that serves to prepare and orient the eyewitness. As such, trait and/or state arousal sensitivity, a physiologically based function that moderates ANS reactions, should delineate both the rate at which a particular eyewitness will succumb to arousal-mediated effects and the type of information given attentional and, therefore, memory preference. On the one hand, hypersensitive eyewitnesses should fall prey to arousal-induced memory distortions at a relatively faster rate than hyposensitive eyewitnesses, distortions in which internal (e.g., sensory) information is increasingly given memory priority over external (e.g., narrative) information, with objectively central information deteriorating at a faster rate than peripheral information (see Table 5.1; and Figs. 5.3 and 5.4). On the other hand, hyposensitive eyewitnesses should show memory distortions at a relatively slower rate and increasingly focus on external information, most notably that which is objectively central to the event, at the detriment of internal and, later in the arousal stream, peripherally external information (see Table 5.1; and Figs. 5.3 and 5.4).

Concurrently, cognitive evaluations, which are psychological in nature, should assign the quality of the experience in question, which itself should reflect one's personal history, personality, and physiological (e.g., sober vs. inebriated vs. high) and affective states, the latter of which being closely tied to the nature of the criminal event (i.e., danger level; e.g., witness vs. victim). While positive (i.e., safety) evaluations, which hyposensitive eyewitnesses are most likely to have, will lead to an ANS dampening effect, negative (i.e., threat) evaluations, which are more characteristic of hypersensitive eyewitnesses, should serve to further excite the ANS. These cognitively moderated ANS reactions should then feedback into the interpretative system, thereby leading to an event-related affective reaction. Once complete,

this affective response should become associated with the event in question, thereby setting the stage for storing the experience into long-term memory (LTM).

Although an eyewitness' arousal sensitivity should delineate the type of crime-related information allocated attention (e.g., internal vs. external), it is the affective load of the event that should predominantly dictate how well (i.e., in terms of type, quality, and quantity) and for how long a memory will be recalled (see Table 5.1). Indeed, affective load should have two memory consequences. First, emotions should add significance to events of impact and, as such, should increase the saliency (or quality) of memory traces, thereby making them easier to recall than events of less personal significance (Christianson, 1989, 1992; Thompson et al., 1997). Second, emotions should add information value to memories. That is, they increase the size (or quantity) of the memory by accelerating information transfer from short-term memory (STM) to LTM. As such, emotional memories (e.g., of crimes) should be sensitive to a number of triggers (i.e., emotional and non-emotional) and therefore more susceptible to free/cued recall than emotionally neutral memories. Given that recall serves to enhance memory, one should expect emotional memories (e.g., of crimes) to be remembered for longer periods of time than memories of neutral events. More generally, the affective load—adding quality and quantity to the memory—should serve to minimize (or protect against) memory decay. Objectively significant events that are subjectively interpreted as relatively benign (e.g., as low-to-moderate in intensity) should decay at a faster rate than those interpreted as significant (i.e., as moderate-to-high intensity). That is, with all other variables being equal, mundane events should evidence normal forgetting, while events of impact should be remembered quite well and for long periods of time (i.e., particularly if rehearsed), thereby leading to remarkable memories.

Based on differences in trait arousal sensitivity, remarkable memory patterns for criminal/traumatic events should be more common in hyposensitive eyewitnesses than in hypersensitive eyewitnesses given that the former is likely to make a less (and the latter a more) catastrophic interpretation of the situation at hand (see Figs. 5.3 and 5.4). When a hypersensitive develops a remarkable memory, his/her memory is likely to decay at a relatively faster rate than the remarkable memory of a hyposensitive eyewitness because the hypersensitive, in his/her attempt to avoid stimulation, is not as likely to be self-motivated to think/talk about the experience that led to the remarkable memory. Contextual variables are also likely to affect the development of these memory patterns via cognitively moderated affective reactions. Indeed, certain types of events are likely to be interpreted as more significant than others (e.g., being defrauded vs. robbed at gun point) and, therefore, will be differentially resistant to memory decay (e.g., fraud events leading to normal forgetting and an armed robbery to a remarkable memory).

As arousal approaches an eyewitness' trauma threshold (see Figs. 5.3 and 5.4), significantly negative event-related interpretations are likely to occur (i.e., traumatic interpretations). Such interpretations, given their ANS excitatory effects, could lead to post-traumatic responses, the addition of which could have at least two memory consequences. On the one hand, eyewitnesses may attempt to actively avoid thinking of the event proper (i.e., a cardinal symptom of PTSD; APA, 2000). If successful,

this conscious attempt at forgetting could result in fewer memory triggers for the "feared" event and, therefore, lead to a loss of memory detail (i.e., decay) over time, resulting in active forgetting (Yuille & Daylen, 1998). On the other hand and somewhat paradoxically, a PTSD response may lead to intrusive thoughts about the event proper (another defining feature of PTSD; Cooper, 2005). In this situation, the central information of the event would be unconsciously and repeatedly recalled, thereby leading to hypernesia (Scrivner & Safer, 1988)—another pathway to remarkable memories. Arousal sensitivity would decree at which point in the arousal stream eyewitnesses would be impacted by these effects, with hypersensitive eyewitnesses showing these memory patterns at subjectively lower intensity levels and across a wider range of arousal levels than hyposensitive eyewitnesses. It should be noted that the impact of intrusive thoughts, flashbacks and nightmares on memory veracity remains unknown and, therefore, is in need of research.

At a certain point in the arousal stream (i.e., as arousal surpasses the trauma threshold) affective load should also exert its impact on memory processes thereby leading to significant distortions. Although initially benefiting memory storage by making information transfer (IT) more efficient, emotional intensity eventually leads to memory decay by overloading STM resources. At this point, certain pieces of event-related information should be given priority. It is expected that, shortly after surpassing the eyewitness' trauma threshold, sensory information will be given LTM priority in hypersensitives and narrative information will be given priority in hyposensitives. The resulting loss in narrative and sensory information, respectively, could lead to further PTSD symptom formation. The loss of external information in hypersensitive eyewitnesses could be associated with feelings of derealization as reality (i.e., the external world) would become increasingly overshadowed by fantasy (i.e., the internal world). In contrast, the loss of sensory information that hyposensitive eyewitnesses experience could result in feelings of depersonalisation, reflecting the fact that one is losing him/herself in the event at hand (i.e., external world) and, therefore, loses touch with one's own sense of self (i.e., internal world).

As the aforementioned effect increases in magnitude, certain predictable memory consequences should ensue. At their most extreme, derealization and depersonalization during encoding/storage should result in dissociative memories (DM), with hypersensitive eyewitnesses and hyposensitive eyewitnesses being more likely to take an internal and external (or observer) perspective, respectively. Consequently, hyposensitive eyewitnesses who display an observer perspective would remain valuable eyewitnesses, while hypersensitive eyewitnesses who escaped into fantasy would be relatively unhelpful in the investigative process. However, with further increases in perceived arousal, some eyewitnesses—expectedly over represented on the hypersensitivity spectrum—may be rendered relatively amnesic for the event in question. That is, they would be susceptible to the development of dissociative amnesia.

Unbearable (e.g., traumatic) arousal could also take on a subjectively unique quality (i.e., one that has never previously been experienced), which could serve to explain the development of state-dependent memories, as well as red outs (Cooper & Yuille, 2007; Swihart et al., 1999). Events may be ascribed unique affective loads for

several reasons. First, given that cognitive interpretations depend, in part, on one's affective conditioning history, events of extreme intensity would, by definition, be unique. It is expected that hypersensitive eyewitnesses, given their relatively limited arousal history, would be more affected by this intensity than hyposensitive eyewitnesses. Second, specific contextual cues could also result in the creation of unique emotional experiences by reflecting a large discrepancy between pre- and post-crime affective states (e.g., from an extremely pleasant and relatively un-aroused state to a highly negative and intense state; see Russell, 1980). If such an emotional change has never been experienced in the past, then, by definition, it would be interpreted as unique. Although hyposensitive eyewitnesses are arousal seekers, they typically seek arousal in a controlled fashion (i.e., their sensation seeking occurs gradually rather than abruptly) and, consequently, should be as susceptible to this process as hypersensitive eyewitnesses. Third, idiosyncratic filters stemming from specific cognitive distortions (e.g., related to psychopathology or personality disorder) could also lead to unique interpretations. Aside from the ANS inhibitory and excitatory effects, arousal sensitivity should not be a factor in this regard. Finally, given that criminal events of high intensity may serve to cue past emotional memories, competition for attentional and, therefore, memory resources may occur. If the criminal event in question is given attentional/memory priority and if the affective load of the event in question is then combined at the encoding/storage stages with that of the past memory, one would expect the resulting event-related memory to be unique. Unlike other more circumscribed memories, it would reflect a specific emotional combination—a combination that has likely never been previously experienced. Both of these emotional states would then have to be present for retrieval to be successful. For successful retrieval, interviewers would have to attempt to figure out which mechanism led to the state-dependent effects. Presumably, such effects would occur earlier in the arousal stream and over a larger arousal range in hypersensitive eyewitnesses than in hyposensitive eyewitnesses (see Figs. 5.3 and 5.4).

The cueing of past memories by current criminal events could have other memory consequences as well. Barring any other factors and assuming that the current arousing/criminal situations trigger memories of past similar events, the resulting memory impact should depend on the influence of the cued memory upon ANS function via affective feedback mechanisms. If the current situation triggers a memory of a past similar situation with relatively little adverse consequences, the feedback mechanisms would have a dampening effect on the ANS, thereby signalling to the eyewitness that the current situation is less dangerous/significant than would otherwise be the case (i.e., if no memory cueing had occurred). This process may help to explain the development of some script memories. Take, for example, cases of repeated child sexual abuse. The first time the event occurs, the child would have no way of knowing its outcome and, therefore, the resulting memory may be of significance. If the child escapes relatively unharmed, it is possible that s/he learns that the event is not to be as feared as initially thought. Accordingly, the next time s/he is assaulted by the same assailant, who would serve as a memory cue, the child may interpret the event as relatively less significant. With successive assaults, the child may then habituate to the affective load, rendering successive events less and

less subjectively disturbing and, therefore, less and less important in terms of memory allocation—a script memory may result (note: the child would not necessarily need to interpret the event as benign for a script memory to develop). Obviously, there are other types of repeated events that may lead to the development of a script memory (e.g., being the victim of serial robberies or domestic assault). Irrespective of the type of event, the end result may be that the eyewitness ends up developing a script memory regarding what "generally" happened to him/her. Significant departures from the script, however, would likely be of memory significance and, therefore, better recalled (see Yarbrough et al., present volume).

The above notwithstanding, if the current situation triggers a traumatic memory and, therefore, a heightened ANS reaction, then other memory distortions reflecting dissociative processes are expected. For example, the current event may trigger a "flashback" of a past traumatic event, resulting in the formation of a memory that reflects a combination of events (i.e., the flashback and the current situation). In extreme cases, this process could lead to total amnesia for the event at hand (i.e., the dissociative process bars encoding/storage), leaving the eyewitness only able to report about peripheral information (e.g., events that preceded and followed the actual offence). This process suggests that the "red out" phenomenon might reflect not only a state-dependent mechanism (i.e., event-related rage states of a unique affective load) but also dissociative processes (i.e., event-unrelated rage states that are allocated attentional priority; e.g., past jealous episodes).

As previously discussed, memory for criminal/traumatic events can take many forms and any one memory can be characterized by several patterns reflecting different processes occurring at different points in the formation of the memory. For example, one victim of repeated childhood sexual abuse recalled that she "used to" climb up the bedroom wall and enter the red light on the ceiling and "watch" what was happening to the "little girl" (i.e., Cooper, 1999). In this case, the victim described a script memory for abuse from the perspective of an observer. Once the victim took on an observer perspective, this process was repeated in subsequent abuse incidents, leading to the formation of a script. Such a strategy is arguably defensive in nature and is used to depersonalize an experience/memory (Cooper, Kennedy et al., 2002). Similarly, it is not uncommon for eyewitness to have remarkable memories for events that led to and followed an offence, with dissociative memories or amnesia for the event proper.

In addition to the encoding and storage stages of memory, distortions can occur at the retrieval stage, reflecting, for example, recall motivation and retrieval methods. Recall motivation is an important variable to consider when interpreting the validity of eyewitnesses' statements. There are many reasons, for example, that a victim would distort (e.g., embellish, minimize) his/her account of a criminal experience to law enforcement (e.g., fear or protection of perpetrator). These motivations are likely to be accompanied with their own emotional connotations, which could serve to further influence/contaminate memory. Indeed, distortions, irrespective of their motives, could, with time, take on a memory dominant role and, therefore, become reality. Just as active forgetting can lead to memory decay, active confabulation can lead to (false) memory strengthening.

In terms of retrieval mechanisms, the use of leading and suggestive questions by investigative interviewers could lead to false/created memories for event-related information that was either not encoded or poorly encoded in the first place. That memory decays with time suggests a positive correlation between retrieval delay and suggestibility. The impact of questionable interviewing techniques is proposed to be much more significant, in terms of the investigative processes, for hypersensitive eyewitnesses than hyposensitive eyewitnesses. The former, having likely focused internally and, therefore, having little event-related information available, would be suggestible to information of most relevance: objectively central information. In contrast, the latter should be resistant to event-related suggestibility in that it is specifically this knowledge that s/he has at his/her disposal. S/he might, however, be suggestible to peripheral information and explanations regarding how s/he should have experienced the event in question. Arousal sensitivity would further dictate that hypersensitive eyewitnesses become suggestible at lower arousal levels and across a wider range of arousal levels than hyposensitive eyewitnesses (see Figs. 5.3 and 5.4).

Implications

Although certain aspects of our biopsychosocial model of eyewitness memory (Hervé et al. 2007) have been put to the empirical test (e.g., Cooper et al., 2007; Cooper & Yuille, 2007; Griesel, 2008), clearly more research is needed. We suggest that a combination of methods (i.e., laboratory, archival, and field research) be used to study eyewitness memory (also see Paz-Alonso et al., present volume; Yuille, 1993) and to assess and refine our theoretical underpinnings and predictions. At the very least, we suggest that researchers and practitioners pay more attention to individual and situational differences and how they relate to eyewitness memory. Indeed, as reviewed throughout this chapter, there a host of biopsychosocial variables that influence the quality, quantity, and veracity of eyewitness memory. Whether in research or practice, we suggest that investigators assess for predisposing factors (e.g., arousal sensitivity, psychiatric history, neurocognitive impairments), precipitating factors (e.g., state dissociation, arousal, affect, substance use, nature of event), and perpetuating factors (e.g., previous recall attempts, the recall context, types of questions asked, PTSD symptoms) in mock and actual eyewitnesses to be in a better position to explain the observed memory processes and patterns. As detailed above, each of these factors should impact eyewitness memory directly and indirectly and individually and collectively.

Until more research has been conducted on eyewitness memory in general and on our theory in particular, this model of eyewitness memory should be used with caution. As others have suggested (see Yarbrough et al., present volume), effective interviewing (e.g., of witnesses to crimes) is impacted by the investigative interviewer's knowledge of memory processes and patterns. A biopsychosocial basis for understanding these issues would no doubt assist investigative interviews

in becoming more effective. For example, knowing that the use of leading/suggestive questions/interviews could negatively impact eyewitness memory would help interviewers avoid such tactics and ask better, memory-compatible questions. Moreover, knowing that different types of eyewitnesses are more or less susceptible to arousal mediated memory distortions should assist interviewers in making sense of the memory patterns they receive from eyewitnesses. Indeed, assessing the credibility of an account of a crime is heavily dependent on effective interviewing and knowledge of how memory works (see Colwell, Hiscock-Anisman, & Fede, present volume; Griesel, Ternes, Schraml, Cooper, & Yuille, present volume; ten Brinke & Porter, present volume). The pattern of memory that a witness displays should be predictable based on the Hervé et al. (2007) model, with deviations explained within the context of the mediating/moderating variables described throughout this chapter. Otherwise, the credibility of the witness' account should be questioned.

In terms of expert testimony on eyewitness memory issues, it seems clear that eyewitness memory for criminal events is a complex phenomenon mediated by a number of biopsychosocial variables. Simplistic statements by expert witnesses about the negative effects of stress/arousal on memory, for example, are unwarranted (Cooper et al., 2010; Griesel & Yuille, 2012; Yuille et al., 2010; Yuille & Cooper, 2012). Experts would be in a better position to assist the triers of fact if expert testimony—based on laboratory, archival and field research—is evidence based, balanced, and limitations to expert opinions are highlighted, not minimized. This would promote the role of being a true friend of the court.

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