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# 21 Psychobiology of Traumatization and Trauma-Related Structural Dissociation of the Personality

*Ellert R. S. Nijenhuis, PhD*

*Johan A. den Boer*

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About one in five individuals who are exposed to a highly stressful event, such as an event that involves major threat to the integrity of the body, will not integrate the experience into their personality (i.e., will develop a trauma-related disorder) (Brewin, Andrews, & Rose, 2003; Elklit & Brink, 2003). How traumatizing an event will be depends on factors such as the nature of the event(s), the degree of exposure to the event (Fullerton, Ursano, & Wang, 2004), the degree of exposure to prior stressful events (Daviss et al., 2000), and the individual's integrative capacity. For example, particular events such as severe and chronic physical and sexual abuse are traumatizing for most people, and adults with premorbid psychiatric disorders and children will generally be more vulnerable to become traumatized than mentally healthy adults given their lower integrative capacity (Fuglsang, Moergeli, Hepp-Beg, & Schnyder, 2002; Fullerton et al., 2004). Some studies suggest that younger children are even more vulnerable than older children (Vizek-Vidovic, Kuterovac-Jagodic, & Arambasic, 2000).

Nonintegrated, traumatizing experiences do not tend to vanish from a survivor's mind, but remain in a dissociated form. One common form in which survivors memorize these experiences are as traumatic memories (Nijenhuis & Van der Hart, 1999; Nijenhuis, Van Engen, Kusters, & Van der Hart, 2001; Van der Kolk & Fisler, 1995; Van der Kolk & Van der Hart, 1991). Traumatic memories are recurrent, involuntary, and mostly nonverbal, sensorimotor experiences, often charged with intense affects such as fear, sadness, or disgust, that survivors have not integrated. These positive dissociative symptoms include daytime flashbacks, somatic symptoms, panic attacks, or in even more complete reexperiencings of the traumatizing event. Unintegrated traumatic memories can also manifest as nightmares and night terrors. Traumatic memories thus usually go along with hyperarousal, intense bodily reactions, and strong emotionality. However, they can also involve hypoarousal, degrees of bodily anesthesia, and little affect. Sometimes, survivors shift between states of hyperarousal and states of hypoarousal when they reexperience traumatizing events. For example, they may first become hypervigilant, next they may freeze while being hyperaroused, and then they engage in flight or ward-off (the image) of a perpetrator. Finally, they may totally submit and become bodily and affectively numbed.

Another form in which survivors memorize their traumatic experiences is as a more or less complete and coherent narrative that they have not sufficiently realized (Simeon, Guralnik, Schmeidler, Sirof, & Knutelska, 2001). That is, they have not developed full conscious

awareness that the event really happened or that it happened to them, and they do not sufficiently appreciate the personal consequences of the experience. In addition to this lack of realization, some survivors block the retrieval of traumatic memories to the extent that they seem to have forgotten them more or less completely for a time. This partial or complete dissociative amnesia—a *negative* dissociative symptom—can be interrupted by phases in which survivors recollect what happened as traumatic memories.

These different ways of remembering traumatizing events thus coexist in traumatized individuals (Nijenhuis & Van der Hart, 1999). That is, they tend to alternate between reexperiencing traumatizing events in one of more forms and being more or less detached from these painful memories. At one point in time, survivors engage in defensive physical actions in response to perceived threat or real threat (e.g., when traumatization is ongoing) to the integrity of the body. In the next moment, they engage in tasks of daily life, such as taking care of children, earning money, or playing a game, while being depersonalized and partially amnesic for their traumatic experiences.

The survivor's sense of self typically changes with these alternations. They reflect that the personality of traumatized individuals is divided into different dissociative parts, each of which can dominate consciousness and behavior for some time (Nijenhuis & Van der Hart, 1999). These different ways of being-in-the-world are sometimes activated in parallel. In this case, one dissociative part of the personality may intrude the domain of another dissociative part. For example, one part may hear the voice of this other part, and can be intruded by this other part's affects, thoughts, and bodily feelings and movements.

These essential features of trauma-related disorders have met insufficient recognition in psychobiological studies of traumatization. The bulk of the studies to date seem to rest on the implicit assumption that reminders of traumatic experiences will typically evoke reaction patterns that are mediated by the sympathetic nervous system. For example, it is usually hypothesized that trauma survivors will have fear reactions to these reminders that include elevated heart rate frequency (HR) and blood pressure, and that they will commonly activate the "emotional brain" (LeDoux, 2003), including the amygdala. This perspective goes back to Walter Cannon's classic idea of the flight or fight response to major stress, which involves dominance of the sympathetic nervous system. In this chapter, we maintain that this perspective may be overly simplistic as it seems to ignore that survivors may respond with a range of very different response patterns to

salient reminders of traumatic experiences. As indicated, these patterns include (apart from defensive reactions such as flight or fight) very different defensive reactions such as total submission to (perceived) major threat. They also include being detached (Holmes et al., 2005) while focusing on tasks in daily life.

This chapter addresses this psychobiological complexity in reactions to (potentially) traumatizing events. It first presents an introduction into the theory of trauma-related structural dissociation of the personality. A range of psychobiological hypotheses can be derived from this theory. Some of these will be subsequently examined using some recent research findings. (Note: for space, we will not discuss emerging structural neuroimaging research of structural dissociation in this chapter.) The basic idea of the theory is that the personality of trauma survivors is divided in two or more different but interacting dissociative parts, that the functioning of these parts is mediated by different (constellations of) action systems, and that these different action systems relate to different aspects of the central nervous system. The theory thus holds that survivors' reaction patterns to stressors and reminders of stressors depend on the part(s) of the personality that is (are) dominant during the exposure to the stressor. Some conclusions complete the chapter.

## 21.1 THE THEORY OF TRAUMA-RELATED STRUCTURAL DISSOCIATION OF THE PERSONALITY

Many individuals with PTSD or more complex trauma-related disorders alternate between being fixated on traumatic experiences and being detached from them (Nijenhuis & Van der Hart, 1999). As Janet (1907, p. 332) proposed, they alternate between two or more dissociative "systems of ideas and functions that constitute personality." According to the theory of structural dissociation (Nijenhuis, Van der Hart, & Steele, 2002, 2004b; Steele, Van der Hart, & Nijenhuis, 2005; Van der Hart, Nijenhuis, Steele, & Brown, 2004; Van der Hart, Nijenhuis, & Steele, 2006), this alternating pattern reflects failed integration between different parts of the personality. The "emotional" part of the personality (EP; cf. Myers, 1940) is largely stuck in defense from major threat, in particular, threat to the integrity of the body. The "apparently normal" part of the personality (ANP; cf. Myers, 1940) is fixated on fulfilling functions in daily life. As ANP, survivors are more or less detached from traumatic experiences, experience some degree of amnesia, or are depersonalized regarding the traumatic experience and their affects more generally. Using the

metaphor of dissociative parts of the personality, it should not be overlooked that they range from very simple to highly complex. Some dissociative parts encompass just one psychobiological state, whereas others are complex assemblies of such states.

Structural dissociation of the personality may involve constellations of one ANP and one EP, as in PTSD; one ANP and more than one EP, as in complex PTSD (Herman, 1992), also known as disorders of extreme stress (Pelcovitz et al., 1997), and more than one ANP and more than one EP, as seen only in DID. According to the theory of structural dissociation, the extent to which the personality becomes divided depends on factors such as the severity of the traumatization in terms of developmental age at trauma onset, chronicity and intensity of the traumatization, the relationship to the perpetrator(s), and lack of support and social recognition of the traumatic experience(s).

ANP and EP constitute two different psychobiological systems, each endowed with its own sense of self, however rudimentary. According to Damasio (1999, p. 26), consciousness and sense of self are essentially grounded in "a feeling that accompanies the making of any kind of image—visual, auditory, tactile, visceral—within our living systems" and may involve several integrative levels: (1) the proto-self that emerges from the activity of brain devices that continuously and nonconsciously maintain the body state within the narrow range and relative stability required for survival; (2) the core self that relates to core consciousness defined as conscious awareness of the here and now based on the mental representation of how our own state is affected by our processing of an object; and (3) the autobiographical self that involves extended consciousness (i.e., conscious awareness of our personal existence across subjective time).

The existence of the EP can be limited to reexperiencing traumatic memories (i.e., sensorimotor experiences that hardly involve narrative components, if at all) (Nijenhuis et al., 2001; Van der Kolk & Fisler, 1995; Van der Kolk & Van der Hart, 1991). In this case, the EP may involve little more than core consciousness and core self. Yet clinical observations suggest that with recurrent reactivations of traumatic memories and chronic traumatization (and treatment), the EP may develop a degree of extended consciousness and autobiographical self. Even in these cases, however, extended consciousness and the sense of autobiographical self tend to remain quite limited. EPs are typically fixed in past traumatic experiences with absent or only partial awareness of the present or the passage of time. ANPs typically have developed a more substantial degree of extended consciousness, yet

lack personification and realization of the traumatic past and the associated EPs. EPs and ANPs have a narrowed field of consciousness focused on issues relevant to the functions they exert. Dissociative parts involve a sense of self that is different from the pretraumatic sense of self. However, because young children encompass psychobiological systems that are still relatively unintegrated, their pretraumatic sense of self is rather inconsistent and changeable. That is, their sense of self may not be stable even prior to early traumatization.

What psychobiological “systems of ideas and functions that constitute personality” are involved in EP and ANP? These systems should meet a range of shared criteria:

- (1) They must be self-organizing and self-stabilizing within windows of homeostasis, time, and context to control and integrate all the rather coherent complexes of psychobiological phenomena exhibited by ANP and EP;
- (2) They should be basic, functional systems that have been developed in the course of evolution, and should be rather analogous to animal biological systems. These two criteria are derived from clinical observations that ANPs typically engage in essential tasks of daily life such as reproduction, attachment, caretaking, and socialization, and avoidance of traumatic memories that support focus on daily life issues. In contrast, EPs primarily display basic defensive and emotional reactions to the (perceived) threat on which they seem to be fixated;
- (3) They should be very susceptible to classical conditioning, because, as we discuss below, EP and ANP strongly respond to conditioned threat cues;
- (4) They should involve stable characteristics, but also allow for case-dependent variation, because ANP and EP exhibit both invariant and idiosyncratic variations; and
- (5) They should be available early in life, since dissociative disorders can manifest from a very early age.

To address the question of what systems mediate the functioning of ANP and EP, we discuss the concept of personality and explore whether personality entails certain systems that meet these five criteria.

### 21.1.1 PERSONALITY

The hypothesis that structural dissociation of the personality marks an abnormal personality structure requires

a definition of personality. Allport (1961) proposes that personality is “the dynamic organization within the individual of those psychophysical systems that determine his characteristic behavior and thought” (p. 28). His definition raises the question, What “psychophysical systems” would be involved?

Many authors have proposed that an individual’s personality involves a set of distinctive psychological traits, that is, psychological characteristics relatively invariant across contexts such as mental states and environmental situations. More specifically, these traits concern features known as an individual’s temperament. Temperament indicates affective qualities of an individual’s functioning and denotes, for example, to what extent an individual is generally cheerful, optimistic, sad, fearful, or angry, his common interest in exploring his social and material environment, and how responsible he usually feels for his actions.

The study of personality aims to assess the range of psychological traits that distinguish among different individuals. As Davis, Panksepp, and Normansell (2003, p. 57) note, “there is no agreement whether personality should be studied without any theoretical preconceptions or whether theoretical views of human nature are essential to identify the most important psychological dimensions that need to be evaluated.” For example, the currently popular five-factor model that includes Neuroticism—also described as Emotional Stability—Extraversion, Openness to Experience, Agreeableness, and Conscientiousness, was derived empirically without a priori theorizing (Hofstee, Raad, & Goldberg, 1992). This radical positivistic approach has its drawbacks. Thus, in a meta-analytic study of the five-factor model and personality disorder empirical literature, Saulsman and Page (2004, p. 1080) conclude that “a chief factor limiting the progress of [research of the nature of trait maladaptivity] is that the five-factor model is a descriptive account of personality structure, and it does not reveal how personality traits are related to specific behaviors (Benjamin, 1994).” Progress in the study of personality, Saulsman and Page suggest, “requires seeking guidance from existing theories and hypotheses of personality dynamics that complement the five-factor model” (p. 1081).

What theories seem particularly worthwhile to extend our understanding of personality and, more specifically, what psychophysical systems personality would entail? McCrae and Costa (1996) have suggested that the five-factor model represents “genotypic” personality traits. Consistent with this position, various authors have demonstrated a genetic basis for these factors (Cattell, 1986; Eysenck, 1990; Loehlin, 1992; Pedersen, Plomin,

McClearn, & Friberg, 1988; Viken, Rose, Kaprio, & Kowkenuo, 1994). According to Cattell (1986), the “source” traits of personality have physiological roots, and other studies also suggest that personality traits are predominantly determined by biological factors rather than social ones (Bouchard & Loehlin, 2001; Lucas, Diener, Suh, Shao, & Grob, 2000). However, important as it is, the role of biology for personality must not be overstated. First, phenotypic attributes are produced jointly by genetic and developmental processes (Heyes, 2003; Mayr, 1974). As Heyes (2003) notes

The information obtained through natural selection and stored in the genotype cannot produce a phenotype without developmental [i.e., ontogenetic] processes of some kind, and development is not always tightly genetically constrained or canalized (Waddington, 1959) such that it does all and only what natural selection “desires.” Development can produce outcomes, some of them adaptive, that were not anticipated (not specifically favored) by natural selection, and these outcomes may be said to have an ontogenetic source (D.T. Campbell, 1974; Karmiloff-Smith, 1992).

Animal studies have demonstrated that major stress can completely and permanently alter the phenotypic expression of an animal’s genotype (Cools & Ellenbroek, 2002). Thus, an animal of a breed that is extraverted by nature can become introverted for life after major traumatization. On a more general plane, there is mounting evidence that emotional neglect and abuse can significantly or even dramatically affect neurobiological (neurogenesis, neuron migration and differentiation, apoptosis, arborization, synaptogenesis, synaptic sculpting, and myelination) and psychological development, relative to age/developmental windows (Perry, 2002). Genes are required for this development, as well as macro- and micro-environmental stimulation. Thus, development is gene-dependent and user-dependent.

#### 21.1.1.1 Genetic Factors in Personality

The heritable component of personality is associated with variations in multiple alleles and cannot be attributed to a single gene (Livesley & Jang, 2000). It is nonetheless striking that almost every personality dimension studied has been found to have a heritable component, with genetic factors accounting for nearly half the variance on every trait (Plomin, DeVries, McClearn, & Rutter, 1997). Especially adoption studies and twin research have contributed to this conclusion (Kendler, Neale, Kessler, Heath, & Eaves, 1993). Adoption studies (Plomin et al., 1997), as well as studies of twins separated at birth

(Tellegen et al., 1988), confirm the heritability of personality traits. It therefore seems justified to conclude that individual differences in personality and temperament have a strong basis in heredity.

Associations between personality traits and genetic variations derive from many different genes, and are therefore measurable as quantitative trait loci. But, thus far, this line of investigation has been disappointing. Promising earlier reports (e.g., Lesch et al., 1996) have not been consistently replicated (Gelertner, Kranzler, & Lacobelle, 1998). The main reason is that single alleles account for only a small percentage of the variance on any trait. These studies also suffer from the lack of a precise phenotype for personality traits.

The presence of a genetic component in personality also implies that traits should be linked to biological markers. Research in this area is at an early stage. Thus far, the strongest finding has been a strong relationship, established in clinical populations, between low levels of central serotonin activity and impulsivity.

#### 21.1.1.2 Gene-Environment Interaction

The other half of the variance in personality derives from the environment. As recent studies show, environmental factors do not occur in isolation; there exists a gene-environment interaction. Genetic factors may also contribute to the vulnerability for environmental events, and genetic factors also appear to contribute to personality characteristics, which may influence the person’s risk for entering into potentially hazardous situations (Jang, Stein, Taylor, Asmundson, & Livesley, 2003). Maltreatment at a young age, although causally involved in predicting either PTSD, DID, or antisocial behavior increases the likelihood different subtypes of psychopathology even more when a certain genetic or biological predisposition is present (Raine, 2002a, 2002b).

In a prospective study of male children it was found that a functional polymorphism of the gene encoding for monoamine-oxidase-A (MAO-A plays a role in the enzymatic degradation of noradrenalin and serotonin) predicted the occurrence of antisocial behavior only if the children were maltreated (Caspi et al., 2002). This study shows that a specific genotype (low activity of the MAO-A gene) can influence children’s sensitivity and behavioral response toward environmental events. In addition, a polymorphism of the gene for the 5-HT transporter, which determines the availability of serotonin in the synaptic cleft (e.g., in the amygdala) influences the activity of the amygdala (leading to greater activity of the amygdala) when confronted with fearful faces (Hariri et al., 2002). In short, subjects with the short allele



(leading to more serotonin in the amygdala) are more prone to anxiety and to feeling threatened even in non-threatening situations, which may lead to a tendency toward dysfunctional sociability.

The implication of these findings is that our sensitivity for, and interpretation of, environmental events do not occur in a cognitive/emotional vacuum but can be modified by genetic and biological factors. There is a paucity of knowledge about the relative contribution of genetic and environmental influences on biological risk factors for the development of specific personality traits. This issue needs urgent study in the future.

### 21.1.1.3 *Personality and Action Systems*

People's personality manifests in, and can only be inferred from, their predominant affectively charged mental and behavioral actions. Hence, their personality is theoretically perhaps best analyzed in terms of the (constellation of) psychobiological systems that essentially mediate their actions. Many human mental and behavioral actions constitute manifestations of innate, but experience-dependent and in many cases maturation-dependent action systems that are founded in primitive subcortical neural systems that we share with many other creatures, and that in us have become linked with higher cortical functions (Damasio et al., 2000; Lang, 1995; Lang, Davis, & Ohman, 2000; Panksepp, 1998, 2003). Defense, attachment of offspring to parents, parental attachment to and care for offspring, procreation, sociability, energy management, exploration, and play constitute the major action systems (Panksepp, 1998), and each of these may encompass a range of subsystems (e.g., Fanselow & Lester, 1988). Panksepp argued that basic emotional processes arise from distinct psychobiological systems that reflect coherent integrative processes of the nervous system (cf. Ciompi, 1991). In his view, the essence of emotionality is organized on subcortical and precognitive levels, and each of the action systems involves specific patterns of activation of neural networks and associated neurochemical activity in the brain. Lang (1995) suggests that emotions are driven by two major evolutionary derived action systems (i.e., appetitive and aversive subcortical circuits that mediate reactions to primary reinforcers). Carver, Sutton, and Scheier (2000) similarly propose that personality involves approach of rewarding social and material resources, and escape from and avoidance of threat.

Our position concurs with the view of Panksepp and colleagues (Davis et al., 2003, p. 58) that "optimal personality evaluation should be based on empirically based viewpoints that attempt to carve personality along the lines of emerging brain systems that help generate the

relevant psychological attributes." In an original study, Davis et al. (2003) hypothesized that a great deal of variability of personality relates to strengths and weaknesses found in six major action systems. Three of these involve appetitive, approach action systems: Play (playing games with physical contact, making jokes, laughing, expressing joy and happiness), Seek (feeling curious, feeling like exploring, seeking solutions for problems and puzzles, positively anticipating new experiences), and Care (nurturing, being drawn to young children and pets, feeling softhearted toward people and animals in need, feeling empathy, liking to care for the sick, feeling affection for and liking to care for others, liking to be needed by others). Three other action systems pertain to aversion-related, avoidance/escape action tendencies: Fear (feeling anxious or tense, worrying, struggling with decisions, ruminating about past decisions and statements, losing sleep, not typically being courageous), Anger (feeling hotheaded, being easily irritated and frustrated leading to anger, expressing anger verbally or physically, and remaining angry for long periods), and Sadness (feeling lonely, crying frequently, thinking about loved ones and past relationships, and feeling distress when not with loved ones). Sadness thus denotes frustrated attachment needs.

Davis et al. added a seventh category that they described as Spirituality, because of their interest in the highest human emotions. We are not aware of psychobiological evidence for Spirituality (feeling "connected" to humanity and creation as a whole, feeling a sense of "oneness" with creation, striving for inner peace and harmony, searching for meaning in life) as an action system. The essential qualities of religious experience include a direct sensory awareness of a higher power, but also a feeling of having touched the ultimate ground of reality and the sense of the incommunicability of the experience of unity. As all human experience is brain-based the same should be true for these experiences. Available evidence indicates that the dorsolateral prefrontal, dorsomedial frontal, and medial parietal cortices play a role in religious experiences (Azari et al., 2001). Others have suggested that the limbic system including the temporal lobe constitutes the neural substrate for religious experience (for review see Saver & Rabin, 1997).

Davis et al. found strong relationships between scales measuring approach and avoidance/escape action systems and the Big Five. The most robust correlations were Extraversion with Play, Agreeableness with Care and inversely with Anger, Openness to Experience with Seek, and Emotional Stability inversely with the three aversive emotions. Conscientiousness was more weakly associated

with these emotions. Spirituality only correlated (positively) with Caring and Seeking scales. They concluded that each of the six action systems is closely related to at least one of the Big Five personality factors, and that each of the action systems may form a substantial part of the adult five-factor personality structure.

The avoidance/escape action systems (Fear, Sadness, and Anger) were moderately to strongly correlated, and loaded on one factor “low emotional stability.” In regard of these findings, Davis et al. suggested that “negative affect” may emerge as a superordinate personality factor. We speculate that this factor could represent a complex defense system grounded in primitive subcortical brain structures, which we share with many other species. It would include hypervigilance, startle, flight, freeze, total submission (Fear), fight (Anger), and attachment cry (Sadness).

Davis et al. do not claim that the action systems they studied provide a comprehensive representation of human personality. They rather argue that these ancient psychobiological action systems involve defensible core elements of emotional experience and may serve as a foundation for many “higher” mental attributes and faculties. They also point out that there may be other action systems in the human brain and in some other mammals, such as those for dominance, guilt, greed, disgust, and shame. Davis et al. feel that current neurobiological evidence is insufficient for inclusion of these potential factors, and consider that many of those feelings are derived largely through social learning.

However, it is questionable that the emotion of disgust is solely acquired through social learning. The most direct experience of disgust is related to taste aversion, which immediately leads to a characteristic facial expression and sometimes a vomiting response. The second type relates to our animal origin and is disgust of bodily products such as saliva and excretions. Finally, disgust may play a role in moral and legal judgments (Nussbaum, 2004). The emotion of disgust (literal meaning of disgust is: bad taste) is based on the role that objects or events can be potential sources of contamination and transmission of disease (Rozin, Lowey, & Ebert, 1994). Fear and disgust may serve different evolutionary purposes: fear as part of the appraisal of danger (LeDoux, 1995), and disgust to deal with the risk of contamination and disease (Rozin et al., 1994). Moreover, the importance of basic emotions such as disgust in psychiatry prompted some authors to speak of disgust as the “forgotten emotion” (Phillips, Senior, Fahy, & David, 1998).

Using fMRI and electrophysiological techniques, several studies showed that facial expressions of fear

activated the amygdala, whereas expressed disgust specifically activated the anterior insula, together with the medial frontal cortex, thalamus, and putamen (Phillips et al., 1997; Schienle et al., 2002; Krolak-Salmon et al., 2003; Wicker et al., 2003). Another study showed that facial expressions of disgust activated the anterior insula (and caudate and putamen), whereas vocal expression of disgust did not (Phillips et al., 1998). This latter finding differs from studies of other groups who found that the neural system for the recognition of disgust can recognize signals of disgust from different sensory modalities (Lavenex, Pasquier, Lebert, Petit, & Van der Linden, 1999). Finally, it appears that it is indeed the same sectors of the insula responding to the recognition of disgust in others and in the participants’ own experience of disgust (Wicker et al., 2003), supporting the idea that our brain transforms the sight of someone else’s facial expression of disgust into our own experience of disgust (Gallese, Keysers, & Rizzolatti, 2004). It is conceivable, but at present unknown, that DID patients who have been sexually abused during childhood show greater signs of disgust and insula activation compared to DID patients who suffered from physical abuse. We will present evidence later in this chapter that DID patients tend to experience disgust when they listen to a personal trauma script as EP, but not as ANP, and that this emotion is associated with potent insula and caudate activation. The scripts pertained to a range of traumatic experiences, including sexual and physical abuse.

Davis et al. did not include other ancient action systems in their study, notably Reproduction/Lust, Energy Management, and Safety Seeking. We speculate that greed for food and other resources could relate to extremes of energy management and safety seeking (e.g., collecting too much food, overeating; collecting/buying/possessing too many objects [e.g., for shelter, i.e., a house too big]). Sexual predation could involve a mixture of action tendencies of dominance and sexual lust, and oftentimes anger. It seems worthwhile to include these tendencies in future research of personality.

In sum, personality crucially involves two major groups of evolutionary derived but maturation-dependent action systems (i.e., those for approach of rewarding social and material resources, and those for escape/avoidance of perceived threat). More specifically, there is an approach regarding positive social and environmental rewards (Play, Seek, Care), and a fear-related approach of safety cues (Care in the form of seeking reunion with a caretaker when feeling threatened). And there is active physical withdrawal from real or perceived threat or resistance (Anger/Fight), as well as physically passive defense in the

form of total submission, which is characterized by mental escape and avoidance.

### 21.1.2 DISSOCIATIVE PARTS AND ACTION SYSTEMS

The theory of structural dissociation holds that ANP and EP are essentially mediated by (constellations of) these two basic groups of action systems. Action systems closely meet the five criteria of dissociative parts of the personality previously described. They are organizational, evolutionary derived, functional, flexible within limits, and inborn but epigenetic. Action systems are functional in that they activate various types of affective feelings, which help identify events in the world that are either biologically useful or harmful, and generate adaptive responses to many life-challenging circumstances. Although the resulting behavior is unconditionally summoned by the appropriate cues, approach and avoidance are adaptable to prevailing environmental conditions within limits, rather than being mere inflexible responses. For example, flight involves not just running away from threat, but running that is adapted to the current situation in form, direction, and duration. Thus, threat as an unconditional stimulus does not evoke a single unconditional response, but an integrated series of psychobiological responses that can be adapted to prevailing external and internal conditions within limits.

Action systems are epigenetic, that is, the result of influences by nature and nurture. Experiences, especially early ones, can change the fine details of the brain forever. These experiences include learning associations between events. Action systems are susceptible to classical conditioning: for instance, learning that some previously neutral events predict or refer to unconditioned stimuli. These conditioned stimuli tend to reactivate a memory of the unconditioned stimuli, and this association generates action tendencies described as conditioned responses. The conditioned response that an individual develops when perceiving a conditioned stimulus may but need not be identical or even similar to the original unconditioned response to the unconditioned stimulus. For example, the original, unconditioned response may have been flight, whereas the conditioned response may be freeze. However, the emitted response still belongs to a particular category of action systems, in the example, defense. Classical conditioning allows in many cases for some flexibility of response, which allows for adaptation to changeable internal and external conditions.

Subsystems of defense are of particular interest in trauma-related dissociation because of exposure to threat. Each defensive subsystem controls a pattern of

psychobiological reactions that is adapted to meet a particular degree of threat imminence (Fanselow & Lester, 1988). This degree of imminence can be expressed in terms of the time and space that separate the subject from the threat (i.e., the distance between predator and prey), as well as in terms of an evaluation of the defensive abilities of the subject (e.g., the subject's psychosocial influence and physical force). *Pre-encounter defense* involves an apprehensive state with increased arousal, potentiated startle response, interruption of "normal life" behaviors, and nearly exclusive attentional focus on the potential threat. *Post-encounter defense* includes several subsystems: flight, freeze with associated analgesia, and fight. *Post-strike defense* involves total submission and bodily as well as emotional anesthesia. Upon survival, a recuperative subsystem is activated that allows for a return of affective awareness and body sensations (e.g., pain, fatigue), and that drives wound care and rest through social isolation, as well as sleep. Upon recovery, there will be a reactivation of (sub)systems that control daily life interests such as consumption of food, reproduction, and taking care of offspring.

#### 21.1.2.1 EP is Primarily Fixed on Survival under Threat

According to the theory of structural dissociation, EPs are primarily, not exclusively, manifestations of the action system that mediates defense in the face of threat—particularly threat to the integrity of the body by a person—and potentially also of the action system that controls separation panic in relation to caretakers. Both systems serve survival interests and strongly influence the mental and physical experiences and actions of the EP. While EPs essentially rely on evolutionary derived action systems, their manifest form will be shaped by environmental conditions, especially traumatic experiences that evoke threat, in particular those that occurred in early childhood, and subsequent external and internal conditions. These conditions include the degree and quality of social support in the aftermath of trauma, repetition of traumatization, and the degree of structural dissociation between EP and ANP.

#### 21.1.2.2 ANP Primarily Involves Action Systems That Manage Daily Life

Clinical observations suggest that action systems of the ANP primarily function to direct performance of daily tasks necessary to living (work, social interaction, energy control), and some of the tasks related to survival of the species (caretaking of children). ANPs approach attractive stimuli and mentally avoid EPs and their aversive



mental contents. ANPs' escapism from reminders of traumatic experiences can perhaps involve an extreme of the normative and adaptive tendency of action systems to inhibit each other (e.g., we do not tend to eat, sleep, fight, or totally submit simultaneously). Some ANPs may execute daily life action systems with passion, while others do so in more or less depersonalized and automatic ways (e.g., caretaking). This depersonalization probably relates to ANPs' avoidance of emotional and bodily feelings that have become conditioned stimuli for reexperiencing traumatic memories, a hypothesis that will be explored in more detail later. We note in passing that detached, depersonalized functioning in caretaking and attachment may interfere with synchronizations of physiological processes between adult and child that assist the child in regulating states (Field, 1985), potentially leading to structural dissociation in the offspring of dissociative parents (Schore, 2003).

#### 21.1.2.3 *A Dimension of Trauma-Related Structural Dissociation*

In cases of primary structural dissociation, which would characterize simple PTSD, and simple cases of somatoform dissociative disorders (i.e., the ICD-10 dissociative disorders of sensation and movement, described in DSM-IV as conversion disorder), a single EP can include all defensive subsystems. Secondary structural dissociation is a manifestation of a range of defensive subsystems that have not, or not sufficiently, been integrated among each other. Thus the EP may become divided into several EPs that serve different defensive functions. In secondary structural dissociation, some EPs typically display freezing and are analgesic, others are inclined to physically resist threat and experience anger, or totally submit to threat while being severely anesthetic. This threat often consists of reexperiencing (traumatic) memories of severe and chronic childhood abuse and neglect, or in responding to cues that are salient reminders of these events. Insecure attachment to caretakers can also become associated with one or more EPs in secondary structural dissociation. This level of integrative failure is mediated by traumatization that is more severe than that associated with simple PTSD. Secondary dissociation is characteristic of complex acute stress disorder, complex PTSD, complex cases of somatoform dissociative disorders, many cases of dissociative disorder not otherwise specified (APA, 1994), and perhaps borderline personality disorder (APA, 1994) as well.

Many authors refer to states of hypoarousal, as in submission, as dissociative, but exclude sympathetic hyperarousal states from this category (Perry, Pollard, Blakely,

Baker, & Vigilante, 1995; Schore, 2003). However, defining dissociation as a lack of integration among dissociative parts mediated by action systems that may include single or clusters of states implies that hyperarousal states can also be dissociative. But these, as well as states involving analgesia and motor inhibition (freezing), bodily and emotional anesthesia, detachment from environmental cues, and submission (total submission, regulated by the parasympathetic nervous system; Porges, 2001, 2003; Schore, 2003) may all be manifestations of unintegrated subsystems of defense.

In addition to secondary structural dissociation (division of the defensive system, thus of the EP), division of the ANP may also occur. Thus, this *tertiary structural dissociation* (Nijenhuis et al., 2004b; Steele, Van der Hart, & Nijenhuis, 2005; Van der Hart, Nijenhuis, Steele, & Brown, 2004; Van der Hart, Nijenhuis, & Steele, 2006), characteristic only of DID, involves a division among two or more action systems that serve functions in daily life and in survival of the species. For example, one ANP regarded herself as the mother of her children, and another ANP engaged in a job. Remaining as the mother, the patient did not appreciate or understand the interests that she had as a worker, and vice versa. Tertiary structural dissociation does not occur during traumatization, but rather emerges when certain inescapable aspects of daily life become associated with past traumatization, such that systems of daily life become dissociated. Apart from extreme generalization of stimuli that reactivate traumatic memories, tertiary dissociation can also result from traumatization that started before the individual had been able to create a cohesive personality. Early and chronic traumatization may lead to some unclear mix of ANP/EP, where neither can be clearly distinguished. Such complexes are clinically observed in more dysfunctional DID patients.

#### 21.1.2.4 *Structural Dissociation and Disorganized Attachment*

When traumatization by caretakers begins early in the life of the child, a particular style of attachment often develops in the child, termed *disorganized/disoriented* (Liotti, 1999; Main & Morgan, 1996). In normal, middle-class families, about 15% of the infants develop this attachment style, but in cases of maltreatment its prevalence may be up to three times higher (Van IJzendoorn, Schuengel, & Bakermans-Kranenburg, 1999). Thus frightened or frightening parental behavior predicted infant disorganized attachment (Schuengel, Bakermans-Kranenburg, & Van IJzendoorn, 1999). Prospective longitudinal research has demonstrated that disorganized and

avoidant attachment in early childhood, along with age of onset, chronicity, and severity of abuse, predicted dissociation in various developmental stages, up to late adolescence (Ogawa, Sroufe, Weinfield, Carlson, & Egeland, 1997). Both ANP and EP may be insecurely attached to original abusive caretakers or to (positive or negative) substitute caretakers.

Disorganized attachment may neither be disorganized nor disoriented. Instead, it involves concurrent or rapid successive activation of the attachment system and the defense system when primary attachment figures are both the source of protection from threat and the threat itself for the traumatized child. Separation from attachment figures activates the innate attachment system, which evokes mental and behavioral approach to the caregiver. However, approach yields an increasing degree of imminence of threat, and therefore evokes a succession of defensive subsystems (flight, freeze, fight, submission). This approach and avoidance conflict cannot be resolved by the child and promotes a structural dissociation of the attachment and the defensive system.

## 21.2 SIMILARITIES BETWEEN THE HUMAN AND ANIMAL DEFENSIVE SYSTEM

At a general level, Nijenhuis, Vanderlinden, and Spinhoven (1998c) drew a parallel between animal defensive/recuperative systems and characteristic somatoform dissociative responses of trauma-reporting patients with dissociative disorders. Their review suggested that there are similarities between animal and human disturbances of normal eating patterns and other normal behavioral patterns in the face of diffuse threat; freezing and stilling when serious threat materializes; analgesia and anesthesia when strike is about to occur; and acute pain when threat has subsided and recuperation is at stake.

Nijenhuis, Spinhoven, Vanderlinden, Van Dyck, and Van der Hart (1998a) performed a first empirical test of the hypothesized similarity between animal defensive reactions and certain somatoform dissociative symptoms of dissociative disorder patients who reported traumatization. All 12 somatoform dissociative symptom clusters tested were found to discriminate between patients with dissociative disorders and patients with other psychiatric diagnoses. Those clusters expressive of the hypothesized similarity between animal and human models—freezing, anesthesia-analgesia, and disturbed eating—belonged to the five most characteristic symptom clusters of dissociative disorder patients. Anesthesia-analgesia, urogenital

pain and freezing symptom clusters independently predicted the presence of dissociative disorder. Using an independent sample, it appeared that anesthesia-analgesia best predicted the presence of dissociative disorder after controlling for symptom severity. The indicated symptom clusters correctly classified 94% of cases that constituted the original sample, and 96% of an independent second sample. These results were largely consistent with the hypothesized similarity to animal defense systems.

Among Dutch and Flemish dissociative disorders patients, the severity of somatoform dissociation—as measured by the Somatoform Dissociation Questionnaire (SDQ-20; Nijenhuis, Spinhoven, Van Dyck, Van der Hart, & Vanderlinden, 1996; Nijenhuis et al., 1999)—was best predicted by threat to the integrity of the body in the form of childhood physical abuse and childhood sexual trauma (Nijenhuis et al., 1998b). The particularly strong association between the SDQ-20—which includes many items that assess anesthesia, analgesia, and motor inhibitions—and physical abuse has also been found in a range of other populations: nonclinical subjects (Waller et al., 2000), gynecology patients with chronic pelvic pain (Nijenhuis et al., 2003), women reporting childhood sexual abuse (Nijenhuis et al., 2001), psychiatric outpatients (Nijenhuis, Van der Hart, Kruger, & Steele, 2004a), as well as North American (Dell, 1997) and Ugandan patients with dissociative disorders (Nijenhuis & Van Duyl, 2001). Bodily threat from a person and threat to life somatoform disorders also predicted somatoform dissociation in patients with somatoform disorders (Roelofs, Keijsers, Hoogduin, Naring, & Moene, 2002) and nonclinical subjects (Maraanen et al., 2004).

We will discuss in the following recent experimental research suggesting that (1) animal defense-like reactions particularly characterize the EP, and that (2) EPs and ANPs have different psychophysiological stress responses to threat-related stimuli, even if these stimuli are presented preconsciously. Future research will need to decipher whether various EP-subtypes have the hypothesized features of animal defensive subsystems.

## 21.3 PSYCHOBIOLOGICAL INTERFERENCE WITH INTEGRATION OF ANP AND EP

### 21.3.1 PERITRAUMATIC INTEGRATIVE FAILURE

Evocation of the defense system or any other psychobiological system is not dissociative in itself, rather the lack of integration between various systems and subsystems is what constitutes dissociation. Extremely high

levels of arousal may interfere with the execution of normal integrative mental and behavioral actions (Ludwig, Brandsma, Wilbur, Bendtfeldt, & Jameson, 1972; Krystal, Woods, Hill, & Charney, 1991; Siegel, 1999), and integrative functions may be compromised by long-lasting neuroendocrine instability induced by severe stress in early childhood. It is likely that some action systems can be integrated more readily than others. As Panksepp (1998) argued, multiple feedbacks within and across action systems promote synthesis of components of a system (e.g., perceptions, feelings, thoughts, behaviors, sense of self) and integration across action systems. However, integration across action systems that involve quite different and sometimes conflicting functions may be far more demanding than synthesizing components of a particular action system or integrating functionally related systems. If this is correct, the integration of systems dedicated to daily life and survival of the species (ANP), and systems dedicated to survival of the individual in the face of that threat (EP) will fail more readily than integration across subsystems of these two complex systems. Structural dissociation between the ANP and the EP will thus be the basic type of integrative failure, for instance, primary structural dissociation, when overwhelming experiences occur. When stress levels rise, integration of subsystems of defense may be compromised as well, yielding secondary dissociation (i.e., division of the EP).

### 21.3.2 POSTTRAUMATIC INTEGRATIVE FAILURE

Since living organisms have a natural tendency toward integration (Siegel, 1999), what maintains structural dissociation when trauma has ceased and stress-induced monoaminergic reactivity has returned to baseline? According to the theory of structural dissociation, apart from integrative deficiency that relates to enduring neuroendocrine changes induced by stress in early life, integrative failure in the aftermath of trauma also involves fear conditioning.

#### 21.3.2.1 Traumatization and Classical Conditioning

Trauma-related classical conditioning involves association of stimuli that saliently signaled or accompanied the overwhelming event. As a result, these previously neutral cues will thereafter reactivate a representation of the traumatic experience. Thus the essence of classical conditioning is the development of an anticipatory (conditioned stimulus signals unconditioned stimulus) or referential response (conditioned stimulus refers to unconditioned stimulus). For example, the specific mood (e.g., anger) of the caretaker when abusive, as well as the

stimuli that apparently tended to elicit this mood, will tend to become conditioned stimuli.

#### 21.3.2.2 Phobias of Traumatic Memories and Dissociative Personalities

Classical trauma conditioning can also generate effects that support continued structural dissociation (Nijenhuis et al., 2002, 2004b). First of all, structural dissociation is less than perfect. When the EP's traumatic memories are reactivated by potent external (e.g., certain smells, sounds, sights) or internal (e.g., feelings or body sensations) conditioned stimuli, they can intrude into the experiential domain of the ANP. Since traumatic memories represent the traumatic experience, they are formally conditioned stimuli. But the sensorimotor and highly affectively charged properties of these unintegrated experiences are inherently aversive for the ANP and *will therefore act as unconditioned stimuli*. Indeed, when traumatized patients reexperience their terror, it is as if the traumatizing event happens "here and now." When the integrative capacity of the ANP does not suffice for integration of the intruding traumatic memory, the ANP will respond to intrusions (unconditioned stimuli) with typical behavioral and mental defensive action tendencies (unconditioned reactions). The ANP cannot escape from the highly stressful intrusions by behavioral means, but mental escape can be effective, as applies to factual (inescapable) traumatizing events. Thus, typical mental (re)actions of the ANP include retracting the field of consciousness, lowering the level of consciousness (with pseudo-epileptic loss of consciousness as an extreme) manifesting as detachment (cf. the introduction to this chapter), and (re)dissociating the EP and the traumatic memories. At the same time, the ANP learns to fear and avoid internal and external conditioned stimuli that signal or refer to the EP. As time progresses and the dissociative condition continues, there is an ever widening range of conditioned stimuli that the ANP will physically and mentally avoid due to stimulus generalization.

#### 21.3.2.3 Evaluative Conditioning

In addition to classical fear conditioning, evaluative conditioning (Baeyens, Hermans, & Eelen, 1993) of external and internal stimuli may occur. This type of associative learning produces robust effects and involves the presentation of two stimuli conjointly: a neutral stimulus and a stimulus that the individual evaluates in a negative (or positive) manner. As a result of this simple procedure, the previously neutral stimulus adopts a similar negative (or positive) tone. The ANP and EP evaluate traumatic memories differently, and clinical observations strongly suggest that evaluative conditioning applies to

trauma-related structural dissociation. For example, when the traumatic experience pertained to a shameful event, the ANP may learn to be ashamed of the EP, and to despise it, and the EP may learn to despise itself.

In cases of secondary and tertiary dissociation, EPs and ANPs may learn to fear, reject, and avoid each other along similar pathways of evaluative and classical conditioning. In tertiary structural dissociation, avoidance of different ANPs may be based on similar trauma-related issues and conflicts. In summary, many dissociative personalities become phobic of each other. These conditioned effects interfere with normal integrative action tendencies. Hence, structural dissociation involves a strong tendency toward chronicity when the survivor's integrative capacity is low.

In some individuals, alternations between the ANP and EP manifest from the acute phase onward, but other individuals function apparently well for extended periods of time before displaying posttraumatic stress symptoms. However, upon close scrutiny it often appears that the latency period was marked by avoidance of the traumatic memories and associated internal and external cues, yielding a condition of chronic depersonalization. In cases of trauma-related dissociative amnesia as a disorder (APA, 1994), access to the memory of the trauma and to other parts of one's previous nontraumatic life seem to be inhibited (Markowitsch, 1999; Markowitsch et al., 2000; Van der Hart & Brom, 2000; Van der Hart, Nijenhuis, & Brown, 2001; Van der Hart, Brown, & Graafland, 1999).

#### 21.3.2.4 *Relational Factors That Maintain Structural Dissociation*

When significant others deny trauma instead of assisting in the integration of the painful experience, or prohibit talking about it, dissociative tendencies are enhanced. These adverse social influences prevail in intrafamilial childhood sexual abuse (Freyd, 1996), and seem to promote dissociative amnesia (Vanderlinden, Van Dyck, Vandereycken, & Vertommen, 1993). PTSD has been associated with lack of support in the aftermath of traumatizing events (King, King, Fairbank, Keane, & Adams, 1998), and in another study, patients with complex dissociative disorders reported total absence of support and consolation when abused (Nijenhuis et al., 1998b). As the structural dissociation theory predicts, social support can buffer negative effects of exposure to (potentially) traumatizing events (Elklit, 1997; Runtz & Schallow, 1997). It might be that social support provides safety cues, assists the individual in modulating the affective state and biological stress levels, and thus promotes the integration of the EP and ANP.

## 21.4 DIFFERENT SURVIVORS, DIFFERENT PSYCHOBIOLOGICAL REACTIONS TO THREAT

Most traumatic stress researchers assume that different survivors have in principle similar (abnormal) reactions to natural and experimental cues and that their functioning is relatively stable over time. These assumptions are convenient because they allow for straightforward group comparisons between survivor and controls. However, these points of departure are at odds with 150 years of clinical observations and associated theoretical analyses suggesting that the psychobiological condition of traumatized people can be different for different individuals, and are inherently changeable per individual. The theory of structural dissociation holds that this changeability is systematic. That is, the psychobiological functioning of survivors would alternate with the part(s) of the personality that is (are) activated at the time of measurement. The functioning of each of these parts would also alternate to an extent or change with temporary or chronic changes of available mental energy and integrative capacity. For example, ANPs would generally have more integrative capacity than EPs. Some survivors may predominantly display ANPs during measurement, others EPs, and still others may alternate among these different parts, or have parallel activation of different parts.

An increasing number of studies indeed suggest that different survivors can display different, sometimes even opposite, psychobiological features. Such differences also appear in animals (Cohen, Zohar, & Matar, 2003; Cools & Ellenbroek, 2002). They include contrasting cortisol levels and autonomic nervous system reactions, as well as different patterns of cerebral blood flow.

## 21.5 AROUSAL, POLYVAGAL THEORY, AND STRUCTURAL DISSOCIATION

Most psychobiological trauma research is based on the assumption that "arousal," hence traumatic stress, is regulated by the sympathetic branch of the autonomic nervous system. This view, originally proposed by Cannon (1927, 1932), predicts that stress reactions involve fight and flight behaviors and concomitant increases in HR, blood pressure, sweat gland activity, and circulating catecholamines. However, researchers of the animal defensive responses (e.g., Fanselow & Lester, 1988) and several authors on trauma-related dissociation have observed that defense is not limited to increases of "arousal" and active defensive motor actions but also involves passivity and losses (e.g., immobilization, bodily and emotional



anesthesia, and physiological deactivation). As Porges (2003) notes, the rather exclusive focus on the sympathetic nervous system neglects the role of the parasympathetic branch of the nervous system in survival.

Porges's polyvagal theory is more differentiated and details essential neural structures and neurobehavioral systems we share with, or have adapted from, our phylogenetic ancestry (Porges, 2001, 2003). His theory proposes three response systems that relate to different branches of the autonomic nervous system (i.e., the ventral and dorsal vagal branches of the parasympathetic nervous system and the sympathetic-catecholaminergic branch). These systems are related to their own adaptive strategies. In this paradigm, state can be changed in a predictable manner and specific state changes are associated with potentiating or limiting the range of specific behaviors.

The functions of the phylogenetically most recent system is social communication, self-soothing and calming (i.e., a major component of self-regulation and affect-regulation) and inhibition of sympathetic-catecholaminergic influences. This mammalian signaling system for motion, emotion, and communication involves cranial nerve regulation of the striated facial muscles coordinated with a myelinated vagus that inhibits sympathetic activity at the level of the heart. Porges has described this ventral vagal control as the vagal brake. This brake regulates the heart and allows the individual to stay calm in safe environments. The lower motor neurons of this social engagement system are situated in the nucleus ambiguus. This system involves pathways that originate in the frontal cortex. Hence, there is cortical control of these medullary motor neurons.

The second, phylogenetically older system serves active defense from threat, and is dependent on the sympathetic nervous system. This adaptive system innervates the heart to provide the energy required to focus on threat cues, to run, or to fight. The lower neurons are found in the spinal cord. However, individuals can achieve mobilization in two ways. The quickest way is to release the vagal brake. This action instantly activates the heart and thus provides energy for active defense. Individuals can rapidly calm themselves by reengaging the ventral vagal system that decreases metabolic output. The sympathetic system can assist in energy mobilization under prolonged challenge.

The third and phylogenetically oldest system is the dorsal vagal system that serves major immobilization under threat. It provides inhibitory input to the sinoatrial node of the heart (i.e., the heart's pacemaker) via unmyelinated fibers and also provides low tonic influences on

the bronchi. Massive bradycardia (i.e., low HR) may thus be determined by the unmyelinated dorsal vagal fibers. We hold that this system serves total submission rather than mere immobilization.

It seems that Porges does not distinguish between freezing and total submission. However, freezing is very different from dorsal vagal immobilization. Freezing marks being immobile and silent, but ready to explode into motor action. It occurs in close proximity to hypervigilance, flight, and fight, and is probably under ventral vagal and sympathetic control (Nijssen et al., 2000; Nijssen, Croiset, Diamant, De Wied, & Wiegant, 2001). However, the autonomic nervous system is differentially involved in heart rate regulation in fear-conditioned rats and in nonshocked controls (Nijssen et al., 1998). In nonshocked controls a predominant sympathetic nervous system activation results in an increase in heart rate, whereas in fear-conditioned rats the tachycardic response is attenuated by a simultaneous activation of sympathetic nervous system and parasympathetic nervous system. Freezing involves rapid, shallow breathing, high HR, increase of norepinephrine and epinephrine, and high muscle tone. Total submission is associated with low HR and blood pressure, and slow breathing. Freezing is associated with analgesia (i.e., insensitivity for painful stimulation), whereas total submission goes along with bodily and emotional anesthesia (Nijenhuis et al., 1998a). While freezing consumes much energy, total submission involves conservation of energy.

Porges proposes a hierarchical response strategy to environmental challenges with the most recently developed system employed first and the most primitive last. This idea is consistent with Jackson's dissolution theory (Jackson, 1958), and with Janet's ideas on vehement emotions (Janet, 1928). Jackson proposes that "[t]he higher nervous arrangements inhibit (or control) the lower, and thus, when the higher are suddenly rendered functionless, the lower rise in activity" (Jackson, 1958, quoted in Porges, 2001, p. 132). However, Porges adds that "the neurophysiological substrate of specific behavioral states and coping strategies may incorporate activation of a sequence of response systems representing more than one phylogenetic stage" (p. 132). Thus, the response strategies may include transitional blends between the boundaries of the different stages. These may be determined by visceral feedback and higher brain structures, including the HPA axis, and vasopressin and oxytocinergic pathways that communicate between the hypothalamus and the dorsal vagal system.

Porges (2001) maintains that these three systems are not per se activated as a result of dissolution. They would

involve adaptive biobehavioral response strategies to different environmental challenges. When the tone of the ventral vagal complex is high, individuals are able to communicate via facial expressions, vocalizations, and gestures (i.e., via verbal and nonverbal motor actions). When the tone of this system is low, the sympathetic-catecholaminergic system is unopposed and easily expressed to support defensive mobilization or freezing. Finally, when the tone of the dorsal vagal complex is high, there is immobilization in the sense of total submission.

We agree that these systems involve adaptation but also suggest that integration of the three systems is required for adaptive behavior beyond threat exposure (i.e., for adaptation when threat has passed). Thus we hypothesize that structural dissociation involves a lack of integration of the three systems and their blends (see table 21.1). ANP would be predominantly mediated by the ventral vagal complex, as well as EPs that can engage in attachment behaviors, play, and some exploration when they feel safe. However, ANPs also encompass the sympathetic system to a degree in that they engage in defensive actions when they feel threatened, for example, by threatening internal experiences that relate to EPs such as intrusions of traumatic memories that EP retrieves. EPs' active defensive actions would be predominantly mediated by the sympathetic-catecholamine system and their passive defensive actions by the dorsal vagal complex. Primary structural dissociation involves lack of integration of the ventral vagal complex and the two older phylogenetic systems, secondary structural dissociation lack of integration of the sympathetic-catecholamine system and the dorsal vagal complex, or even lack of integration within the sympathetic-catecholamine system. Tertiary structural dissociation additionally involves lack of integration among different subsystems of the ventral vagal complex. Vehement emotions denote the individual's failure to engage in efficacious, goal-directed mental and motor actions within or across any of these three psychophysiological complexes. To the extent that these

emotions dominate, the individual does not manage to use energy supplies, such as mental and physical energy, for adaptive, creative actions within any psychophysiological system.

Porges (2001) argues that mobilization is associated with increases in cortisol, whereas immobilization (i.e., total submission) involves reduced cortisol secretion because the dorsal vagal complex has an inhibitory influence on the HPA axis. Furthermore, oxytocin is associated with vagal processes, and vasopressin with sympathetic processes. Vasopressin stimulates the HPA axis during chronic stress (Aguilera & Rabadan-Diehl, 2000) and is involved in active behavioral strategies aimed at coping with threat (Ebner, Wotjak, Holsboer, Landgraf, & Engelmann, 1999). Release of oxytocin would be associated with perceiving the environment as safe (e.g., with recognition of familiar individuals, and attachment), hence would promote the ventral vagal system. Release of vasopressin may be a component of a response profile related to the perception that the environment is unsafe, and that active behavioral defense is required. Interactions among cortisol, oxytocin, vasopressin, and norepinephrine occur (Haller, Albert, & Makara, 1997).

In this context, it can be hypothesized that ANPs and EPs have different psychobiological, including neuroendocrine and psychophysiological profiles. EPs would theoretically have different neuroendocrine profiles compared to ANPs and healthy controls, and some types of EPs would have different neuroendocrine profiles than other EPs. For example, notably when they perceive threat, EPs that typically engage in freeze, flight, or fight would have increased cortisol and catecholamine levels, and totally submissive EPs decreased cortisol (cf. Porges, 2001). ANPs that feel safe would have higher levels of oxytocin, as would EPs that are essentially mediated by attachment (cf. Uvnas-Moberg, 1997), whereas most EPs would have higher levels of vasopressin (Teicher, Andersen, Polcari, Anderson, & Navalta, 2002; cf. Porges, 2001). ANPs would likely have low basal levels of norepinephrine, as

**TABLE 21.1**  
**Dissociative Parts and the Polyvagal Theory: Some Hypotheses**

Ventral vagal parasympathetic system	Social communication, exploration of the environment attachment, play	ANP; EPs when feeling safe
Sympathetic-catecholaminergic system	Behavioral defensive actions (e.g., taking care in traffic)	ANP
Sympathetic-catecholaminergic system	Hypervigilance, freeze, flight, fight	EPs when threatened
Dorsal vagal parasympathetic system	Total submission	EPs when threatened

is suggested by low basal norepinephrine in depersonalization disorder (Simeon, Guralnik, Knutelska, Yehuda, & Schmeidler, 2003).

The theory suggests that EPs that engage in active defense when they feel threatened have increased HR, blood pressure, and decreased skin conductance response compared to ANPs. It also maintains that totally submissive EPs have decreased HR and blood pressure when exposed to (perceived) threat. Furthermore, “sympathetically mediated” EPs, “parasympathetically mediated” EPs, and ANPs would all have different patterns of cerebral metabolism. For example, EPs would have more activity in amygdala, insula, and somatosensory cortex. These brain structures are known to be involved in emotional reactions to perceived threat. ANPs would have more activity in the anterior cingulate and the medial prefrontal cortex (mPFC) when exposed to major reminders of traumatizing events (i.e., brain structures that exert inhibitory influences on the “emotional brain”). ANPs would also have more activity in parietal multimodal sensory association areas in this situation. However, all dissociative parts would have less frontal activity compared to mentally healthy controls because dissociative patients involve lower integrative capacity than mentally healthy individuals. The theory proposes that ANPs will tend to become depersonalized and feel detached when exposed to reminders of traumatizing events, and depersonalization is associated with surplus metabolism in the parietal multisensory association areas. This detachment/ depersonalization could relate to conscious as well as pre-conscious mental actions—conscious and subconscious inhibition of emotional reactions, including perception of trauma-related internal (e.g., sensations) and external stimuli. As clinical observations suggest, many ANPs display efforts to evade reminders of traumatizing events and other trauma-related stimuli. Their mental escapism prominently include the narrowing of attention of these parts to concerns of daily life, which might include, we speculate, conscious or unconscious effort to keep the ventral vagal system online. We will now explore some recent findings in the light of these hypotheses.

## 21.6 DIFFERENT REACTION PATTERNS IN DIFFERENT SURVIVORS

### 21.6.1 DIFFERENT NEUROENDOCRINOLOGICAL FEATURES IN DIFFERENT SURVIVORS: CORTISOL

Some scientists maintain that survivors have elevated cortisol levels compared to controls, and others hold that survivors have depressed cortisol. Very few of them have

hypothesized that different survivors can have different cortisol levels. However, this possibility is suggested by early and more recent neuroendocrine studies. Price, Thaler, and Mason (1957) found that most patients anticipating high-risk elective cardiac surgery had relatively low preoperative cortisol levels. These patients were those who used disengagement coping strategies such as emotional avoidance, denial, and withdrawal in the face of the impending surgery. Parents of fatally ill children with low cortisol levels also used disengagement as a coping style (Friedman, Mason, & Hamburg, 1963; Wolff, Friedman, Hofer, & Mason, 1964). In 1967, Bourne, Rose and Mason, documented that special forces soldiers

who used disengagement coping had lower cortisol levels on the day they expected a massive overrunning by the Vietcong than on the days before and after the expected attack, whereas men who were forced to remain engaged with the life-threatening situation because of the nature of their duties (the officer and the radio operator) showed increased cortisol levels. (Mason et al., 2001, p. 388)

Vietnam veterans with PTSD who felt guilt over their military actions in Vietnam (i.e., who were emotionally engaged in their trauma history at the time of measurement) had elevated cortisol, whereas veterans with PTSD who were emotionally numb, avoidant, and generally disengaged had low cortisol levels (Mason et al., 2001).

Mason et al. suggested that emotional engagement and disengagement may represent primary (i.e., immediate) and secondary (i.e., subsequent avoidant) emotional responses to traumatizing events. In our terms, the immediate reactions could denote EP engaging in flight, freeze, or fight, and the avoidant reactions ANP or EPs under dorsal vagal control. We are not aware of direct studies of cortisol levels in ANPs and EPs.

Recent studies have shown that genetic factors influence HPA axis functioning. There is accumulating evidence that variants of the glucocorticoid (GR) receptor affect the cell's sensitivity for glucocorticoids and thus contribute to the large intraindividual variability of HPA axis reactivity in nonclinical samples (DeRijk, Schaaf, & de Kloet, 2002). However, it is questionable whether different GR polymorphisms also contribute to the cortisol-response in PTSD and DID. There is only one study in PTSD in which it was found that subtypes of GR polymorphisms were not more frequent in PTSD compared to controls. The only positive association was a reduced cortisol baseline level in a subset of PTSD patients that was associated with the presence a GR polymorphism (Bachmann et al., 2005). Whether this relationship also holds for DID is at present not known.

### 21.6.2 DIFFERENT PSYCHOPHYSIOLOGICAL FEATURES IN DIFFERENT SURVIVORS

Several studies have found that survivors tend to have elevated HR and blood pressure in the acute stage of the disorder (Bryant, Harvey, Guthrie, & Moulds, 2000; Shalev et al., 1998), and when exposed to perceived threat cues such as script-driven imagery (Kinzie et al., 1998; Orr, 1997; Orr et al., 1997; Shalev, Peri, Gelpin, Orr, & Pitman, 1997) or loud tones (Orr et al., 2003). These effects could be due to sympathetic control, but also to release of the vagal brake. Some preliminary findings indeed suggest that elevated sympathetic tone in survivors in response to mild cognitive challenge can relate to a dysfunctional parasympathetic system (Sahar, Shalev, & Porges, 2001).

Kinzie et al. (1998) and Osuch et al. (2001) found that only a proportion of survivors had increased psychophysiological responses to general emotional challenge and to trauma cue exposure. These subgroups have been labeled physiologic responders and physiological nonresponders. Lack of HR increases to challenge in a substantial proportion of PTSD patients may suggest not a flight or fight, but a “giving up response” that involves inhibition (i.e., total submission). This inhibition could be related to dorsal vagal parasympathetic control in these survivors. In our terms, absent HR increases or rather HR decreases to emotional challenge mark EPs that engage in total submission, whereas absent HR changes to such challenge would be characteristic for ANPs. Flight, freeze, and fight EPs would have increased HR.

HR reflects both sympathetic and parasympathetic nervous system activity and can be measured both tonically (i.e., beats per minute at rest) or phasically (i.e., change in response to a stimulus). Accelerations in HR to a stimulus are thought to reflect sensory rejection or “tuning out” of noxious environmental events, while decelerations are thought to reflect sensory intake or an environmental openness (Lacey & Lacey, 1974). Emotionally, HR has been associated with the experience of anxiety. As such, high-tonic HR is thought to reflect fear, while low-tonic HR may reflect fearlessness.

One of the most consistent findings is the reduced resting HR in antisocial behavior in children and adolescents with externalizing behavior (Ortiz & Raine, 2004). Raine (1993) noted that of 14 relevant studies, all replicated the finding of reduced resting HR in the antisocial groups. Low HR is a robust marker independent of cultural context, with the relationship having been established in the United Kingdom (e.g., Farrington, 1997), Germany (Schmeck & Poustka, 1993), New Zealand (Moffitt & Caspi, 2001), the United States (e.g., Rogeness, Cepeda,

Macedo, Fisher, & Harris, 1990), Mauritius (Raine, Venables, & Mednick, 1997), and Canada (Mezzacappa et al., 1997).

Lack of HR changes to emotional challenge may relate to negative dissociative symptoms, suggesting parasympathetic dominance. Thus, adult raped women with high degrees of negative dissociative symptoms had lower HR when talking about their rape compared to survivors with low degrees of negative dissociation (Griffin, Resick, & Mechanic, 1997). In general, there was a suppression of autonomic physiological responses in the high dissociation group. Delinquent, traumatized adolescents with many negative dissociative symptoms also had lower HR compared to those with few negative dissociative symptoms (Koopman, Carion, Sudhakar, Palmer, & Steiner, 2000). This effect was more pronounced when the survivors spoke in a free association task, compared to talking about their most stressful life experience. However, higher mean HR was found among youths reporting greater frequency and intensity of adverse childhood experiences. We suggest that these differences could relate to the activation of different types of dissociative parts.

Schmahl, Elzinga, and Bremner (2002) also reported that survivors of childhood abuse can have very different subjective psychological and physiological reactions to trauma scripts. A woman with PTSD and a woman with histrionic personality disorder had elevated HR and blood pressure during the experiment. However, a woman with borderline personality disorder and a “dissociative” reaction in response to an abandonment script (i.e., negative dissociative symptoms) had an extreme decline in physiological reactivity.

### 21.6.3 DIFFERENT NEURAL ACTIVITY IN DIFFERENT SURVIVORS

Lanius et al. (2002) studied the neural circuitry underlying the response patterns of sexual-abuse-related PTSD patients to trauma scripts using fMRI. They found that the reactivity depended on whether the patients tended to reexperience the traumatizing event or become detached. They did not describe reexperiencing the traumatizing event as a positive dissociative response, and described detachment as a dissociative response, although this might rather involve some different kind of alteration of consciousness (see Fallacy chapter).

Compared to controls, the PTSD patients who became detached showed more activation in the superior and middle temporal gyri (Brodmann area [BA] 38), the inferior frontal gyrus, the occipital lobe (BA 19), the mPFC (BA 10), the parietal lobe (BA 7), the medial cortex (BA



9), and the anterior cingulate gyrus (BA 24 and 32). However, the PTSD patients who reexperienced traumatizing events showed significantly less activation of the thalamus, the anterior cingulate gyrus (BA 32), and the medial frontal gyrus (BA 10/11) than did the comparison subjects. In terms of the theory of structural dissociation, reexperiencing constitutes a positive dissociative response and probably an EP engaging in active defense, whereas what Lanius et al. called a dissociative response pertains to negative dissociative symptoms, and possibly a detached ANP or EP.

Similarly, Lanius, Hopper, and Menon (2003) described a husband and wife who had developed PTSD in the context of a very serious motor vehicle accident in which they saw a child burn to death and in which they feared they too would die. Whereas both reported peritraumatic dissociative symptoms, they exhibited very different subjective, psychophysiological, and neurobiological responses to trauma-script-driven imagery that caused them to reexperience the accident. The husband successfully had managed to rescue himself and his wife by breaking the window shield while feeling extremely aroused. She could hardly move because she was frozen. When reexperiencing the accident, he was very psychologically and physically aroused, and she felt numb and frozen. Thus, they reengaged in their original response patterns. His HR increased 13 bpm from baseline, and had increased activity in his anterior frontal, anterior cingulate, superior and medial temporal, thalamic, parietal, and occipital brain regions. She had no HR change from baseline and had only increased activity in occipital regions. Lanius et al. (2002) concluded that their “fMRI results demonstrate that PTSD patients can have very different responses, both subjectively and biologically, while reexperiencing traumatic events” (p. 668).

## 21.7 DIFFERENT PSYCHOBIOLOGICAL REACTIONS FOR DIFFERENT DISSOCIATIVE PARTS

The studies discussed so far demonstrate that different survivors can have very different psychobiological profiles. A range of studies of DID patients suggest that different dissociative parts of the personality can have different psychobiological profiles that are not reproduced by DID-simulating controls. Differences have been reported in electrodermal activity (skin conductance; Ludwig et al., 1972; Larmore, Ludwig, & Cain, 1977), EEG—in particular in the beta 2 band (Coons, Milstein, & Marley, 1982; Hughes, Kuhlman, Fichtner, & Gruenfeld, 1990;

Ludwig et al., 1972; Putnam, Buchsbaum, & Post, 1993), visual evoked potentials (Putnam et al., 1992), regional cerebral blood flow (Mathew et al., 1985; Saxe et al., 1992), autonomic nervous system variables (Putnam et al., 1993), optical variables (Birnbaum & Thomann, 1996; Miller, 1989; Miller & Triggiano, 1992; Miller, Blackburn, Scholes, White, & Mammalis, 1991), and arousal (Putnam, Zahn, & Post, 1990).

While these studies are valuable, it is difficult to say what the data actually tell beyond suggesting that these physiological data sets “are most parsimoniously explained by regarding the alter personalities [i.e., dissociative parts of the personality] as discrete states of consciousness” (Putnam, 1997, p. 138). Advances in the field critically depend on theoretical predictions with respect to the *kind* of differences that exist among different *types* of dissociative parts of the personality. As indicated, the theory of structural dissociation offers such predictions.

### 21.7.1 PSYCHOPHYSIOLOGICAL REACTIVITY

Reinders et al. (2006) studied the psychophysiological reactions of DID patients to auditory scripts while functioning as ANP and as fearful EP. In this first and only study to date of ANP and EP dependent psychophysiological functioning, each participant listened to two scripts. One script involved a neutral personal memory that the ANPs and fearful, thus emotionally engaged EPs, experienced as a personal narrative memory, and the other script described a traumatic experience that EPs but not ANPs regarded as a personal experience. Reinders et al. hypothesized that EPs, compared to controls, would only have increased physiological activity, and subjective emotional and sensorimotor reactions to the trauma scripts.

These hypotheses were strongly supported by the results. ANPs and EPs did not have increased HR and blood pressure in response to neutral memories, compared to each other and compared to baseline. However, EPs but not ANPs had highly significant increases of HR and systolic blood pressure compared to baseline and neutral script exposure when listening to the trauma scripts. As was also hypothesized, EPs had significantly less HR variability compared to ANPs when these dissociative parts listened to the trauma scripts. EPs but not the ANPs had strong subjective emotional and sensorimotor reactions to the trauma scripts. Only EPs reported a spectrum of primary emotions, including fear, anger, and disgust, and experienced many positive and negative somatoform dissociative symptoms such as being physically touched,

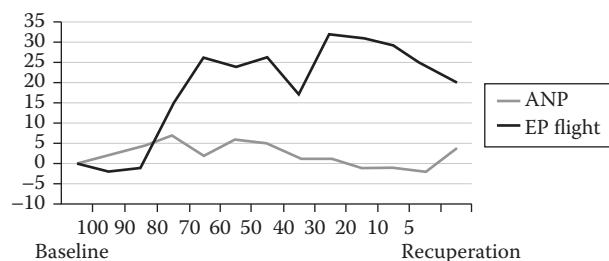
having visual images of the traumatic experience, smelling smells, and bodily paralysis.

To exclude that the participants in this study responded to demand characteristics of the experiment, Reinders et al. (2008) explored whether DID simulating controls would replicate the findings for DID patients (Reinders et al., 2006). They hypothesized that neither low nor high fantasy prone healthy controls who were instructed and highly motivated to simulate ANP and EP would have increased HR or blood pressure and decreased HR variability when they simulated EP and listened to audio-taped descriptions of painful memories. It is difficult for non-PTSD patients to simulate physiological responses marking traumatized patients (Gerardi, Keane, & Penk, 1989; Orr & Pitman, 1993). Moreover, previous studies demonstrated that simulating controls generally were not able to produce psychophysiological state-changes equivalent to those in DID patients (Putnam, 1997). Reinders et al. (2008) found that low and high suggestible, fantasy prone healthy individuals had similar levels of HR and blood pressure whether they simulated ANP or EP, and whether they listened to audiotapes with descriptions of neutral personal memories and of painful personal memories. These findings strongly suggest that the performance of authentic ANPs and EPs in DID cannot be explained as effects of fantasy proneness and motivated role-playing.

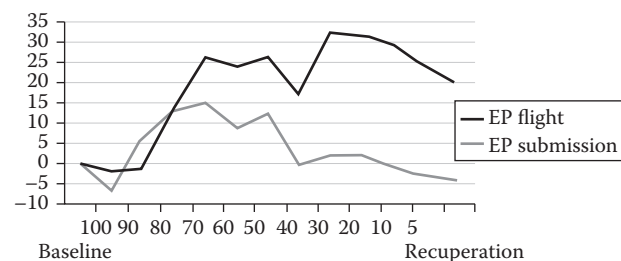
Nijenhuis (2004) documented HR and bodily movements in response to perceived threat cues of ANPs and EPs of patients with complex dissociative disorders. This exposure constituted a clinical exercise designed to help the patients develop assertive reactions, notably to stop ongoing abuse or threats of further traumatization. As ANPs, the patients did not have HR changes, looked composed, and reported that they had felt at ease during the exposure. As EPs that engaged in freezing or in inclinations to ward off the “threat” cue (a small, insignificant object

that the therapist moved in the direction of the patient’s face), the patients had sharp increases of HR. These EPs had very fearful facial expressions, were totally fixated on the moving object, and reported intense fear, inability to move (freeze), or a strong impulse to run (flight). Some tended to assume a fetal body posture. Sometimes “fight” EPs became activated during the exposure, but these parts did not dare to execute their impulses to ward off the object. Finally, as EPs that engaged in total submission, patients had decreasing HR, averted their gaze, and reported that they mentally left their body. Some report amnesia for the experience after the exposure. Figures 21.1 to 21.4 provide some examples of HR responsivity of ANPs and EPs to the test. Nijenhuis, Matthes, and Sack currently study DID patients as ANP and as “sympathetic” and “parasympathetic” EP, as well as mentally healthy controls who simulate ANP and EP, to stimuli that are likely conditioned threat stimuli for survivors of chronic interpersonal traumatization. They move objects (i.e., a piece of plastic, and picture of an angry face) in 10 steps from 100 cm to 5 cm in the direction of the participant’s face, and assess a range of variables, including continuous HR and HR variability, breathing patterns, eye movements, facial and body movements, and galvanic skin conductance, as well as blood pressure, and subjective emotional and sensorimotor reactivity.

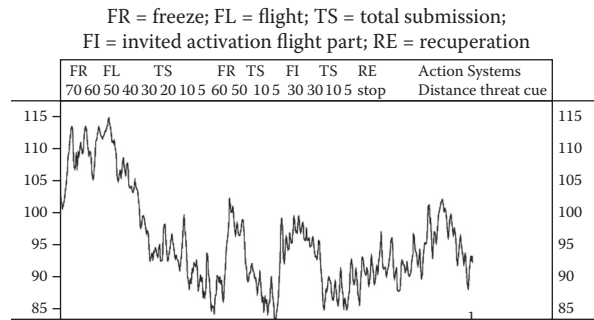
Emotional support during “threat” exposure in the form of a hand of a trusted person on the back prevents extreme increases and decreases of psychophysiological activity (Nijenhuis, 2004; see fig. 21.4). This support likely activates the ventral vagal nervous system, more specifically, the attachment action system. The ventral vagal system implies the vagal brake, and inhibits full activation of defensive system in response to potent reminders of traumatic experience (i.e., conditioned stimuli). In other words, emotional support raises the survivors’ integrative capacity.



**FIGURE 21.1** Heart rate changes compared to baseline for different dissociative parts in a DID patient upon exposure to approaching picture of a man with an angry facial expression.



**FIGURE 21.2** Heart rate changes compared to baseline for different dissociative parts in a DID patient upon exposure to approaching picture of a man with an angry facial expression.



**FIGURE 21.3** Heart rate frequency in a patient with Dissociative Disorder NOS-1 during exposure to approaching perceived threat cue.

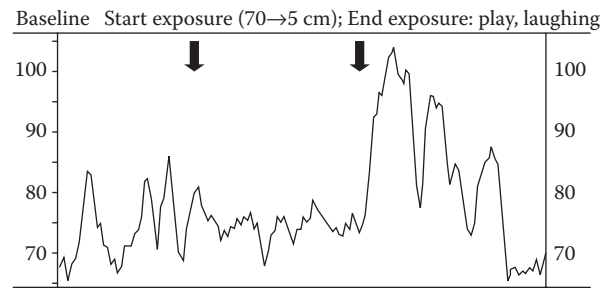
## 21.7.2 ANP AND EP DEPENDENT NEURAL ACTIVITY

### 21.7.2.1 Supraliminal Exposure to Perceived Threat

The study in which psychophysiological reactions of ANP and EP in DID patients to neutral and trauma scripts were examined, also included assessment of rCBF patterns to these challenges using positron emission tomography (PET; Reinders et al., 2003, 2006). As hypothesized, exposure to neutral memories that the patients regarded both as ANP and EP as a personal memory did not yield any difference in regional cerebral blood flow patterns but major differences emerged between ANP's and EP's psychobiological responses to trauma scripts that only the EP regarded as a personal memory.

Compared to ANPs, EPs had more increased activity (or rCBF) in the amygdala, insular cortex, the somatosensory areas I and II in the parietal cortex, and the basal ganglia. This activity may reflect that EPs receive major somatosensory information that these parts interpreted in alarming and painful ways (amygdala and insular cortex), and that urged them to generate defensive motor plans (basal ganglia). EPs also reported disgust when listening to the trauma scripts. This disgust may relate to the observed increase of activation in the insula and caudate (see page \*). Compared to ANPs, EPs had more brain metabolism in the occipital cortex (BA 19: visual perception), the parietal cortex (BA 7/40: somatosensory integration), the anterior cingulate (BA 24 and 32: inhibition of emotional reactions), and several other frontal areas, including BA 10 (planning, self-awareness). Many of these areas were also involved in the detachment that some PTSD patients displayed in Lanius's study.

As suggested, the major activity for ANPs in BA 7, BA 40, and BA 19 may be linked with depersonalization. Depersonalization is related to several negative somatoform dissociative symptoms, for example, experiencing



**FIGURE 21.4** Heart rate frequency of DID patient involved in Figure 1 and 2 in response to a picture of a male with an angry facial expression that is moved from 70 cm to 5 cm in the direction of the patient's face in a therapy session. This time, the hand of the co-therapist whom the patient has learned to trust is on the patient's back. The activated parts are the EPs that otherwise engage in flight and freeze. The experienced support is associated with a stable HR, which effect may reflect dominance of the ventral vagal system.

the body as a foreign object. Simeon et al. (2000) reported that the disorder was associated with functional abnormalities along sequential hierarchical areas, secondary and cross-modal areas of the sensory cortex (visual, auditory, and somatosensory), as well as areas responsible for an integrated body schema. More specifically, they found less blood flow in right temporal cortex (auditory association area), and more metabolism in parietal somatosensory association area and multimodal association area. Dissociation and depersonalization scores among the sample were strongly correlated with activation patterns in the posterior parietal association area (BA 7).

It thus seems that integrative failure with respect to bodily cues—which may be at the heart of basic forms of consciousness (Damasio, 1999)—is related to dysfunctioning of the temporal, parietal, and occipital association areas. Indeed, “[t]here is a hierarchy of sensory processing in the brain, from primary sensory areas to unimodal and then polymodal association areas and finally to the PFC” (Simeon et al., 2000, p. 1786). Depersonalization and negative somatoform dissociative symptoms may thus relate to dysfunction of the posterior association areas, which negatively affects the input into the prefrontal cortex. ANPs indeed report low body awareness, and feel generally more or less detached from their body.

To return to Reinders et al.'s symptom provocation study of DID, reduced activity in the PFC for EPs suggests lack of inhibition regarding emotional reactivity. Stress hormones also interfere with the activation of the mPFC. Thus, elevated levels of norepinephrine were

associated with dysfunction of the PFC (Arnsten, 1999). Interestingly, the reverse is also true. Reduced activity in neural networks in the PFC has been shown to increase c-FOS (one of the immediate early genes responding to environmental stimuli) expression in the paraventricular nucleus, thus leading to increased stress-vulnerability (Gerrits et al., 2003).

Stress hormones related to interference of the mPFC presents a major problem of affect regulation in that hippocampal (McCormick & Thompson, 1982) and medial prefrontal (Armony & LeDoux, 1997) information processing are crucially involved in inhibiting the amygdala. Bremner et al. (1999) documented mPFC and anterior cingulate dysfunction in women with and without PTSD who reported childhood sexual abuse (CSA). The participants were exposed to neutral personal memories and to descriptions of personalized CSA events. CSA scripts were associated with greater increases in rCBF in portions of the PFC, posterior cingulate, and motor cortex in women with PTSD than in those women without PTSD. These scripts also induced alterations in rCBF in the mPFC (i.e., decreased blood flow in subcallosal gyrus and the anterior cingulate. Compared with women who had not developed PTSD, those with PTSD also had decreased blood flow in the right hippocampus, fusiform/inferior temporal gyrus, supramarginal gyrus, and visual association cortex.

Reinders et al. (2008) recently reported that healthy controls who were instructed and motivated to simulate an ANP and an EP were unable to generate neural network patterns that marked genuine ANPs and EPs in DID patients. This failure pertained to low fantasy-prone individuals, as well as to high fantasy-prone controls. These findings are at odds with the sociocognitive theory of DID, but corroborate the theory of trauma-related structural dissociation of the personality.

“Host” parts of the personality in patients with DID (i.e., ANPs) had less cerebral blood flow in the orbitofrontal cortex bilaterally than did healthy controls (Şar, Ünal, & Öztürk, 2007). They also had more blood flow in median and superior frontal regions and occipital regions. These findings also generally corroborate the theory of structural dissociation.

#### 21.7.2.2 *Subliminal Exposure to Perceived Threat*

Preconscious information processing plays a key role in responding to unconditioned and conditioned threat cues and in fear-related learning (Davies, 2000; Dolan, 2000; LeDoux, 1996; Morris, Ohman, & Dolan, 1998). The theory of structural dissociation considers that ANPs aim to avoid this threat, and that EPs will selectively

attend to these cues. Thus in an original study, Hermans, Nijenhuis, van Honk, Huntjens, and Van der Hart (2006) hypothesized that dissociative personality-dependent reactivity to (un)conditioned threat will be evident following exposure to cues that are presented very briefly in order to preclude conscious perception. More specifically, the effects of exposing the ANP and EP in DID patients to masked neutral, fearful, and angry facial expressions were tested.

Whereas ANPs named the color of the mask that immediately followed the experimental stimuli more quickly when this stimulus involved angry facial expressions compared to exposure to neutral facial expressions, EPs did not show differential responses to these cues. DID-simulating controls showed the reverse pattern: a tendency toward longer response latencies after exposure to angry faces when enacting ANPs, and a tendency toward shorter reaction times after exposure to angry faces when enacting EPs. The interaction “group (genuine DID vs. DID-simulators) x condition (angry vs. neutral faces)” was statistically significant. Because this effect was absent when comparing fearful and neutral faces, it was specific for cues that signal an increased possibility of attack.

The results are consistent with the hypothesis that ANPs avoid subliminal threat cues by means of gaze aversion, and that EPs particularly attend to bodily threat from a person, with increased sympathetic tone. The response of the EP is pathological in that angry faces represent social threat that can be reduced by gaze aversion: a social cue that signals submission to a dominant individual. On the other hand, the results of the study are at odds with the theory that DID involves effects of suggestion and role-playing.

If ANPs can preconsciously avoid externally presented (un)conditioned threat cues, it is reasonable to assume that they can also preconsciously avoid internal (un)conditioned threatening stimuli. Hence, it seems possible that the ANP preconsciously avoids the EP and its memories, as the theory of structural dissociation holds. Some neurobiological data are consistent with the interpretation that dissociative amnesia involves inhibited access to episodic memory. Markowitsch and his colleagues have demonstrated that trauma-related dissociative amnesia as a disorder (APA, 1994) can be associated with reduced blood flow in parts of the brain that are normally activated during retrieval of autobiographical memories (Markowitsch, 1999; Markowitsch, 1997; Fink, Thone, Kessler, & Heiss, 1997; Markowitsch et al., 1997, 1998, 2000). Moreover, partial regaining of these memories was correlated with a return to normal



blood flow in these brain areas (Markowitsch et al., 2000).

### 21.7.2.3 *Limitation*

The experimental DID research of Reinders et al. and Hermans et al. is limited to women, which may have affected the results. Preclinical studies have suggested large gender differences with respect to responsivity to identical stressors (e.g., c-fos expression in the PFC and other brain regions) (Trentani et al., 2003). Hence, the degree of activation of various brain structures may be dependent on gender. Next, enhanced activity of the right (but not the left) amygdala in men, and enhanced activity of the left (but not the right) amygdala is related to enhanced memory for emotional films (Cahill et al., 2001). For the time being, we disregarded this complexity, but remark that future research should control for gender.

## 21.8 POSITIVE FEEDFORWARD EXCITATION (EP) AND NEGATIVE FEEDBACK INHIBITION (ANP)

Based on the findings presented, we now give an overview of how EP and ANP seem to have different psychobiological reactions to stimuli these parts consciously and unconsciously perceive as threat.

### 21.8.1 EP-DEPENDENT RESPONSIVITY TO THREAT

Exposure to major external threat causes rapid activation of the defensive system by the amygdala and related structures. This is mandatory for survival, as is learning and memorizing by means of classical conditioning that which signals or refers to threat. The range of threat-related responses orchestrated by the amygdala includes activation of the sympathetic nervous system and the HPA-axis, defensive behavior (through the central grey), startle response, and stress-induced hypoalgesia (Aggleton, 2000). The lateral amygdala receives sensory inputs directly from the sensory thalamus and indirectly from the sensory cortex. The lateral amygdala projects to the central nucleus of the amygdala, which projects to structures controlling defensive behavior (flight, freeze, fight, total submission), autonomic arousal, hypoalgesia, stress hormones, and potentiated startle. Thus, the amygdala will be hyperactivated in the face of threat (unconditioned stimuli), will encode and store associations between conditioned and unconditioned stimuli (e.g., conditioned stimulus signals unconditioned stimulus), and will modulate trauma memories more generally.

When conditioned stimuli (re)appear, the amygdala and other aspects of the emotional brain and the defensive systems tend to become reactivated.

Hyperactivation of the defensive system during traumatic stress may produce hypermnnesia through mediation of the basolateral nucleus of the amygdala. The basolateral amygdala has a major role in stress-mediated neuromodulatory influences on memory storage (Cahill, 2000; McGaugh, Ferry, Vazdarjanova, & Roozendaal, 2000). Post-event memory consolidation for emotional experiences involves not only the basolateral amygdala, but the stria terminalis as well. This is a major afferent/efferent amygdala pathway, which interacts with peripheral stress hormone feedback locally in the amygdala, and with emotional memory storage elsewhere in the brain (Cahill, 2000).

Reactivated traumatic memories represent internal threat and aversion (disgust) in that these memories are not narratives but somatosensory and emotionally charged experiences. Findings of Reiman, Lane, Ahern, Schwartz, and Davidson (2000) suggest that internal threat cues (including body signals) are associated with activity of the insula. We already noted a correlation between activation of the insula and disgust. Because the insula have afferent/efferent connections with the amygdala, internal threat cues may activate the amygdala through this path.

Hyperactivation of the amygdala in the EPs exposed to external and internal threat cues (angry faces) may be related to failed inhibition of the amygdala and insula by the hippocampus and the mPFC due to excessive release of stress hormones: uninhibited positive feedforward loops would seem to stabilize the defensive system, and impede the integration of EP and ANP. In this context, reactivation of traumatic memories and the defensive system (the EP) by conditioned stimuli implies sensitization rather than modulation of associations between conditioned and unconditioned stimuli. Finally, hyperactivation of the defensive system/limbic structures and potent somatosensory activity combined with relatively low levels of prefrontal cortical activity could perhaps explain why in most cases EPs have only developed a quite limited degree of extended consciousness.

Thus it seems that exposure of the EP to (perceived) threat cues (re)activates defensive responses with concomitant lack of contextual information processing, uninhibited conditioned emotional responding within limits of homeostasis, and hampered integration of traumatic memories. Hypermnnesia, sensitization, and maintenance of structural dissociation between ANP and EP can co-occur.

### 21.8.2 ANP-DEPENDENT RESPONSIVITY TO THREAT

Because ANPs displayed reactivity to masked angry faces, it seems unlikely that the amygdala and related brain structures were not activated at all when ANPs were exposed to these threat cues. However, in the EP, the emotional brain is strongly activated. While the EP selectively attends to threat cues, the ANP averts its gaze from threat and selectively attends to cues that matter to daily life functioning. It seems possible that there is transient activation of the lateral amygdala by means of input from the sensory thalamus when the ANP is exposed to threat. However, due to ANP's mental avoidance of threat cues and retraction of the field of consciousness to matters of daily life, the lateral amygdala could become readily subject to a form of negative feedback inhibition. When emotional systems that regulate daily life are in executive control, the amygdala—which has a role in selective attention (Gallagher, 2000)—and related structures may operate in a mode that is different from the mode associated with the defensive system.

It is known that activation of the PFC inhibits the amygdala. Therefore, another explanation could be that as the ANP has to rely more on executive functions in order to function in daily life, more frontal networks are activated. Thus the ANP recruits more neural networks such as the dorsolateral PFC and other PFC-related areas, thus leading to inhibition of the amygdala.

Because ANPs are often depersonalized, studies of DID could help understand ANP reactivity to threat in various trauma-related disorders. Depersonalization is related to several negative somatoform dissociative symptoms (e.g., experiencing the body as a foreign object), and involves functional abnormalities along sequential hierarchical areas, secondary and cross-modal areas of the sensory cortex (visual, auditory, and somatosensory), as well as areas responsible for an integrated body schema (Simeon et al., 2000). Perhaps the ANP's lack of sensory perception, including bodily and peripheral stress hormone feedback, could be instrumental in inhibiting the defensive system, hence, the insula and amygdala, and the responsivity it orchestrates. One way to study the presumed negative feedback and positive feedforward loops would be to apply functional MRI while ANPs and EPs are exposed to external and internal threat cues.

## 21.9 CONCLUSION

The integrative functions of the human mind can be hampered by overwhelming events, especially when these events begin early in life, are recurrent, involve threat to

the body and to life itself, and are accompanied by compromised attachment, and lack of social recognition and support. Trauma-related structural dissociation does not involve an accidental division of the personality. Clinical, empirical, and experimental evidence rather suggests that trauma-related structural dissociation of the personality reflects a lack of integration among specific psychobiological action systems, and this lack of integration may also pertain to different aspects of the human central nervous system. The primary form of this structural dissociation involves failed integration between systems dedicated to daily life and survival of the species, and systems dedicated to the survival of the individual in the face of severe threat. Positive and negative dissociative symptoms are manifestations of structural dissociation of the personality. They are different from alterations of consciousness that do not imply a division of personality (for a review of the psychobiology of these alterations see Vaitl et al., 2005). However, traumatization can also involve phenomena such as lowering and retraction of consciousness. For example, many EPs have a lower level and smaller field of consciousness than ANPs.

The evidence to date suggests that in PTSD and the dissociative disorders, (re)activation of the defensive system—metaphorically addressed as the “emotional” part of the personality, EP—by trauma-related cues implies increased activation of the amygdala, insula, and related structures, and decreased activation of the hippocampus, anterior cingulate gyrus, mPFC, and perhaps other prefrontal areas as well. The amygdala orchestrates a range of unconditioned and conditioned reactions to threat, including sympathetic and parasympathetic nervous system activity, analgesia, defensive motor reaction patterns, subjective emotional feelings such as fear, and retraction of the field of consciousness to threat cues in the immediate, subjective present. These reactions seem to lack modulation by the PFC. However, when the psychobiological systems that involve daily life functioning (i.e., the “apparently normal” part of the personality, ANP) are dominant, threat cues are avoided (gaze aversion, mental inhibition), and attention is directed to cues that have a bearing on daily life. The depersonalization and negative somatoform dissociative symptoms that characterize the ANP may be related to disturbed metabolism in the somatosensory association areas. While structural dissociation may be adaptive when the integrative level is not sufficient to integrate both systems, continued structural dissociation is maladaptive when integration of traumatic experiences would be feasible.

To date, research of PTSD and most research of dissociative disorders have largely overlooked that findings

may depend on the type of dissociative parts of the personality that dominates the functioning of the patient at the time of measurement. In this regard, at a minimum, the theory of structural dissociation can serve as a heuristic for future research of trauma-related dissociation. More specifically, the theory may be of help (1) in selecting minimal sets of variables needed to assess the different types of dissociative parts that patients with trauma-related dissociative disorders encompass; (2) in conceptualizing and studying the features of these different types of parts in terms of these essential variables; and (3) in conceptualizing dynamics of transitions between these different dissociative parts that constitute these patients' personality (cf. Vaitl et al., 2005).

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