25 Biological Aspects of Self-Esteem and Stress

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25.1 The Role of Personality in Coping with Stress

Psychological stress begins with the perception of a threat, such that situational demands are experienced as exceeding the individual's available resources for coping. This sets in motion a cascade of psychological and neuroendocrinological responses, including the activation of the hypothalamic–pituitary–adrenal (HPA) axis with the subsequent release of cortisol, an endocrine marker of the stress response. The activation of the HPA axis under acute threat can be considered a basic adaptive mechanism in response to alterations in demand, as one of its functions is to increase the availability of energy substrates in different parts of the body, and allow optimal adaptation to changing demands from the environment. However, psychological stress—and the emotions that tend to accompany threat perception such as anxiety and fear—can interfere with performance and the effective self-regulation of behavior. Moreover, prolonged (chronic) activation of the HPA axis can lead to negative outcomes including suppression of the immune system and subsequent illness, increased blood pressure, and heightened risk of infections and other serious conditions such as diabetes and hypertension (e.g., McEwen 1998, 2002).

Thanks to Lazarus (1966), who has devoted much of his work to the study of stress, behavioral scientists now know much about the interindividual variability in the stress response. Lazarus noted early on that stressful conditions per se fail to produce reliable effects on task performance (Lazarus et al. 1952). Keeping all situational variables constant, the same stressor can have a minimal effect, lead to performance improvements, or result in significant performance impairments across different people. This led Lazarus and others to suggest that individual differences in motivational and cognitive variables are likely to interact with situational components. What is considered threatening for some, and thus stressful and performance impairing, might be considered as stimulating by others, and thus produce beneficial effects on performance.

Subsequent research identified the appraisal process as crucial in explaining the impact of psychological variables on the stress response. Any internal or external stimulus is perceived as stressful only if it is appraised as harmful or threatening. According to Lazarus, this is a two-stage process, where the primary appraisal of a stimulus as benign/irrelevant versus threatening/challenging is followed by a secondary appraisal that compares the demand of the situation with the available resources, and in the case where the demands exceed the resources the individual is

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becoming stressed. The importance of appraisals (Lazarus 1966) has received recent validation with the identification of "social evaluative threat" as the single most important factor in determining the stressfulness in laboratory studies (Dickerson and Kemeny 2004). The social appraisal could thus be considered a special form of the secondary appraisal process proposed by Lazarus, where the social demands of the situation are compared to the (perceived) social resources. Obviously, a number of personality factors could play a significant role here as well.

25.2 The Importance of Self-Esteem and Locus of Control in the Perception of Stress

Over the years, we have conducted a series of studies to test the notion that the personality variables self-esteem and locus of control play a central role in the appraisal of many situations as threatening, and thus contribute to the experience of stress. Self-esteem is broadly defined as the value people place on themselves. Locus of control refers to the belief that the outcome of events is either more dependent on one's own actions (internal) or others (external; DeLongis et al. 1988; Lo 2002; Petrie and Rotheram 1982; Whisman and Kwon 1993). Epidemiological studies have shown that low self-esteem is associated with negative life outcomes, including substance abuse, delinquency, unhappiness, depression, and worsened recovery after illnesses (e.g., Hoyle et al. 1999; Leary and McDonald 2003). On the other hand, high self-esteem has been linked to happiness and longevity (Baumeister et al. 2003). In studies of aging, a positive self-concept and internal locus of control predict successful aging, predicting independence, cognitive stability, and general health (Baltes and Baltes 1990; Markus and Herzog 1991).

Not surprisingly, internal locus of control and self-esteem are usually highly correlated. The key link of these variables to the experience of stress lies in their impact on the appraisal of a given situation. We postulate that in the appraisal of whether a given situation might be threatening and harmful, or benign, self-esteem and internal locus of control systematically interact with situational factors. If a person attributes little importance to him or herself, and thinks that he or she has little impact on the outcome of his or her own actions, this person will more quickly appraise situations as uncontrollable and unpredictable, and consequently will be more likely to experience situations as threatening, and harmful.

25.3 Endocrinological Evidence for the Role of Self-Esteem and Locus of Control in the Perception of Stress

The first evidence for the impact of self-esteem and locus of control on stress perception emerged when we exposed participants to repeated psychological stress, using the Trier Social Stress Test (TSST; Kirschbaum et al. 1993). In this standardized laboratory stress paradigm, participants have to give an impromptu speech and perform serial subtraction tasks in front of an audience, usually for about 10 min. The audience consists of two to three persons who are instructed to maintain a neutral expression, being neither explicitly rejecting nor confirmative in their facial expression or gestures. In addition, the task is audio- and video-recorded and participants are instructed that the recording will later be analyzed by trained psychologists for verbal and nonverbal contents. During the speech, the audience interacts with the participant only to indicate the amount of time that is left to talk, or to ask specific questions. In the case that a participant has nothing more to say, they remind the participant that there is time left to continue the speech. During the serial subtraction task, the participant is interrupted only when making a mistake. The participant is then corrected and instructed to start the task over.

The TSST is specifically designed to induce a significant amount of social-evaluative threat, combined with uncontrollability, and indeed has been shown to be a powerful stressor, stimulating the HPA axis and leading to significant increases of free cortisol within 15–30 min following the

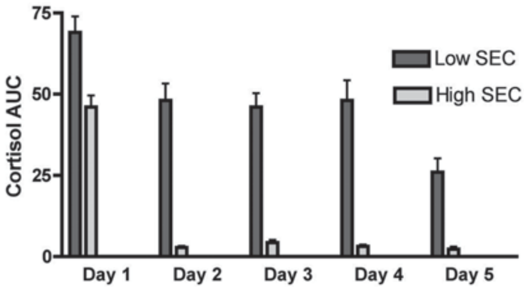

Fig. 25.1 Cortisol responses (area under the curve) on repeated exposure to the Trier Social Stress Test (TSST) on 5 subsequent days in participants with high self-esteem and high locus of control (High SEC; $n=13$) and low self-esteem and low locus of control (Low SEC; $n=7$)

onset of the task (e.g., Kirschbaum et al. 1992). In this first study, we aimed to validate the hypothesis that in humans, repeated exposure to the same stressor would lead to quick habituation of the stress response (Ursin et al. 1978). To test the habituation of the stress response, a total of 20 young healthy male college students were exposed to the TSST on 5 subsequent days. For this purpose, the TSST was modified using different speech topics and serial subtraction tasks on each day.

Notably, we found that only 13 of the 20 participants showed the typical habituation pattern, with a normal stress response on day 1 being significantly reduced on day 2, and no longer present on the subsequent days. In the seven remaining participants, however, the cortisol stress response continued to be present on all days, and only showed a tendency to decline toward the end of the testing period (Fig. 25.1). When analyzing the psychological variables, it became apparent that low internal locus of control and low self-esteem were the best predictors of failing habituation of the cortisol stress response to repeated stress exposure (Kirschbaum et al. 1995). This can be interpreted as a sign that these personality variables at least interact with, if not determine, people's appraisal of a situation during repeated exposure to a stressor.

We attributed the absence of differences in the stress response between the two groups of participants on day 1 to the effect of novelty. The novelty of the situation might have made it unpredictable and uncontrollable for everybody on the first exposure, and might thus have "masked" the impact of personality variables on stress perception and response. Thus, one conclusion at the time was that, to reveal the effect of personality variables on the stress appraisal and response, one will likely require at least two exposures to the same stressor.

At the same time, additional benefits can be gained from exposing participants to more than two repetitions of the same stressor. When looking at the strength of the correlations between the magnitude of the endocrine stress response and the personality variables, we noticed that the correlations grew stronger with repeated exposure. That is, the magnitude of the correlation between the combined stress response of the first 2 days was stronger than the first day alone, the magnitude of the correlation of the first 3 days was stronger than the first 2 days, and so on. In fact, the strongest correlations were found between the aggregated stress responses of all 5 days combined and the personality variables (Pruessner et al. 1997). Because the effects of novelty were likely an influence only on day 1, it can be speculated that other factors must have been at play.

One such factor could have been statistical in nature: Any error associated with the endocrine measures would be presumably random, and by aggregating across several endocrine measures the errors would have cancelled each other out, thus increasing the strength of the association. At the same time, there is likely also an influence of the change of the endocrine response dynamic over time at play here, because the group with low self-esteem and low internal locus of control continued to respond strongly to the psychosocial stressor, while the group with normal to high levels of self-esteem showed completely absent stress responses starting at day 3. Thus, the participants with greatly varying personality profiles moved further away from each other endocrinologically, over time. Because the correlational strength of the endocrine/personality relationship was not as strong when looking at the endocrine profile of later days alone, there is likely a combination of factors at play here, with the above two contributing significantly, and other factors also likely playing a role.

It can be argued that personality variables tend to have relatively weaker effects when situational factors are very strong. In a second study, we thus reduced the threatening aspects of the situation and found that self-esteem and locus of control could then have an impact on the perception of stress already on the first exposure to a stimulus. In this study, we combined computerized mental arithmetic with induced failure to invoke stress. In the experimental design used in this task, 52 students performed the task on computer terminals in front of them. Half of the students were exposed to a difficult version leading to low performance compared to an easy version of the task with high performance for the other half. The students played the task in three 3-min segments, and had to announce their performance score after each segment to the investigator, who wrote the scores down on a board for everyone to see. Saliva sampling before, during, and after the task allowed us to assess the cortisol dynamics in relation to this paradigm (Pruessner et al. 1999).

Notably, this task only triggered a significant cortisol release among participants who were in the low-performance group *and* had low self-esteem combined with low internal locus of control. Neither low performance alone nor low self-esteem and internal locus of control alone were significant predictors of cortisol release, supporting the notion that these personality variables produce effects only in interaction with a potentially stressful situation (Fig. 25.2). In line with the appraisal perspective we outlined at the beginning of the chapter, we suggest that people's appraisal of the situation is at the core of this interaction. In addition, we conclude from this study that the milder form of stress enabled us to see personality effects despite the fact that we used a single exposure paradigm. If a potential stressor is mild enough so that it will lead to a perception as threatening only in those participants that experience low self-esteem and low internal locus of control, then the association with the endocrine stress response is likely to emerge at the initial exposure. Subsequent research from other laboratories has confirmed the link we observed between low self-esteem and the stress response (e.g., Ford and Collins 2010; see also Martens et al. 2008).

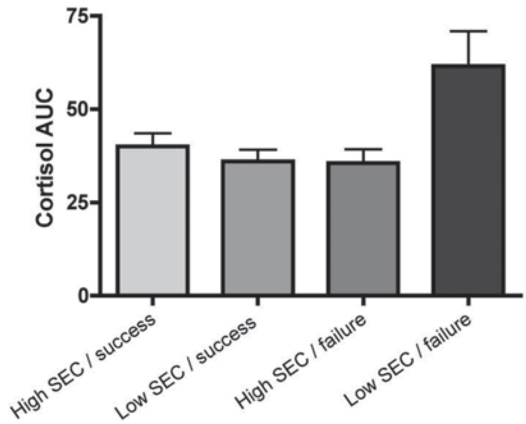

Fig. 25.2 Cortisol stress responses to the Trier Mental Challenge Task (TMCT) in four groups of participants, separated for high and low self-esteem and locus of control, and high and low performance in the mental arithmetic. The performance was manipulated by the investigator

25.4 The Hippocampus as a Possible Mediator of the Relationship between Self-Esteem, Locus of Control, and Stress

Studies on brain correlates of personality variables and endocrine function in humans have only recently started to appear. Nevertheless, initial evidence points to a critical role of the hippocampus at the interface of personality and stress responses. The hippocampus is one of the major limbic system structures involved in the regulation of the stress response (Fuchs and Flugge 2003), and variations in hippocampal volume have shown to be systematically linked to excessive HPA axis activity (Sapolsky 1999; Sapolsky et al. 1986). Early models postulated that associations between hippocampal volume and HPA axis activity might represent the consequence of excessive exposure of the hippocampus to glucocorticoids, due to their powerful neurotoxic properties (Sapolsky et al. 1986).

More recently however, evidence has surfaced that questions the role of glucocorticoid neurotoxicity in affecting hippocampal volume (Swaab et al. 2005). Instead, neurodevelopmental factors might have a more dominant effect in determining hippocampal volume, and in turn HPA function (Engert et al. 2010; see also below). Functionally, the hippocampus is the primary structure for memory contextualization, and it is here that a link to self-esteem and locus of control could occur. When faced with a potentially threatening and harmful situation, people may activate memories of past events to inform their appraisal of the current event. However, if specific situational and environmental characteristics associated with negative past events cannot be recalled, this lack of awareness of situational circumstance can lead to an overgeneralization of negative past events, and thus an increased likelihood to consider the current situations as stressful as well. Thus, poor contextualization due to impaired hippocampus function could be linked to higher stress responses on the one hand, and lower self-esteem on the other (for related arguments, see Goosens 2011; Pham et al. 2005). Another question that is linked to this argument is whether smaller is always worse, and bigger is always better, when referring to variations in brain volume and functional consequences. It is probably oversimplifying to think of this relationship in a strictly linear fashion, but it can be assumed that there is at least a certain range of normality where this association is linear.

We thus tested the hypothesis of a link between hippocampal volume, personality variables, and stress responses in 20 healthy young male college students. All participants underwent an extensive psychological procedure for the assessment of personality variables, including self-esteem and locus of control (Krampen 1991; Rosenberg 1979). In addition, participants underwent structural magnetic resonance imaging (MRI) employing a structural T1-weighted acquisition protocol, which produces high-resolution (isotropic 1 mm) images of the cerebrum (Mazziotta et al. 1995). Our in-house manual segmentation protocol was then applied to all images after nonuniformity correction, signal-intensity normalization, and Tailarach-like transformation for standardization of brain size. The manual segmentation then allows for volumetric assessment of the hippocampus (Pruessner et al. 2000). Finally, all participants were exposed to a computerized stress task, similar to the mental arithmetic task described earlier. Saliva samples before, during, and after the task accompanied the testing to assess the cortisol stress response.

Results first replicated earlier findings of mental arithmetic stress: Only the participants with low self-esteem and low internal locus of control showed a significant release of cortisol. Extending earlier findings however, a correlation emerged between the cortisol stress response and self-esteem ($r=-0.45$, $p<0.05$). Furthermore, a strong correlation emerged between the cortisol stress response and the total hippocampal volume ($r=-0.53$, $p=0.03$), supporting the idea that the size of the hippocampus is related to the regulation of the HPA (Fig. 25.3a). Finally, supporting our initial hypothesis, we also observed a link between internal locus of control and hippocampal volume ($r=0.66$, $p=0.006$; Fig. 25.3b), and self-esteem and hippocampal volume ($r=0.58$, $p=0.02$; Fig. 25.3c).

Testing for the specificity of the effect with regard to the hippocampus, total brain gray matter was employed as control structure in correlations with both personality variables and cortisol response. None of the correlations with total brain gray matter were significant, suggesting that the observed relationships were indeed specific to the medial temporal lobe area and the hippocampus. This was the first research we are aware of linking self-esteem to hippocampal volume, although the finding has been independently replicated since (Kubarych et al. 2012).

25.5 Personality Variables, Brain Structures, and Stress Responses in a Developmental Context

An obvious follow-up research theme that arises from these results is to better understand the observed relationships among personality variables,

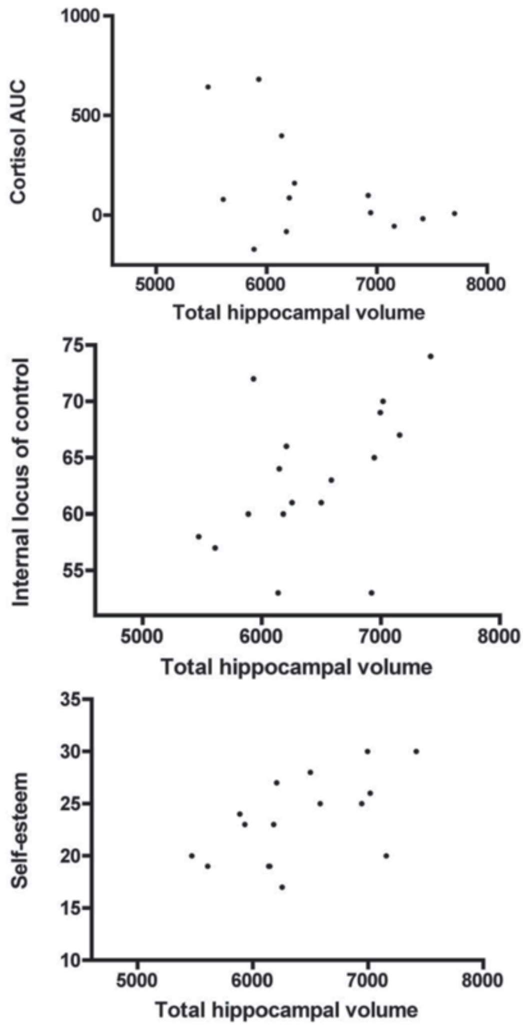

Fig. 25.3 Correlation between hippocampal volume and cortisol stress responses to a mental arithmetic task (**a**), hippocampal volume and locus of control (**b**), and hippocampal volume and self-esteem (**c**) in a group of 16 healthy young male college students

hippocampal volumes, and stress responses. Future research will have to address the direction of the observed relationship between personality, neural structures, and endocrine responses, as well as the origin of these relationships. While we are not at a point where we can present conclusive answers, a number of observations allow us to carefully formulate some hypotheses backed up by recent findings.

According to the "glucocorticoid cascade hypothesis" (Sapolsky et al. 1986), periods of excessive and chronic stress could lead to damage in those areas of the brain that are rich in receptors for glucocorticoids—prominently among them, the hippocampus. Because the hippocampus is further involved in the inhibition of subsequent activity of the HPA axis (through glucocorticoid receptors on its surface it becomes aware that cortisol has been released and signals to the hypothalamus to shut down further HPA axis activity—a process called negative feedback), a damaged hippocampus would be impaired in its ability to relay the negative feedback signal, and thus an excessive or prolonged activation of the axis after stress would occur. This model would explain why lower hippocampal volume is associated with higher cortisol stress responses (the hippocampus is less capable of shutting down HPA axis activity), and it could further explain why those with higher stress responses could have lower self-esteem (the smaller hippocampus would be not as good as a bigger hippocampus in memory contextualization). What it would not explain necessarily is how the hippocampus would become damaged in the first place: Is a onetime traumatic stressor sufficient, or is a period of chronic stress required? There is further a potential developmental process in which reduced hippocampal volumes with stress and aging become associated with changing levels of cortisol and self-esteem. While the early studies by Sapolsky et al. (1986) in rodents could produce some evidence for such a scenario, studies in humans that have been performed since have produced rather inconsistent results.

The question of glucocorticoid toxicity in the human brain is a very rich field of studies, and it would be beyond the scope of the current chapter to try and list all of the evidence. However, there is one piece of evidence that is particular compelling in suggesting that a strict model of toxicity might not work as suggested, at least in humans. This evidence comes from patients diagnosed with Cushing's syndrome, a condition with excessive glucocorticoid production often caused by a tumor in the pituitary, who display cognitive disturbances. Moreover, upon assessment of their brain function and integrity, these patients present with reduced hippocampal volumes. However, once the underlying reason for their excessive glucocorticoid production is found and they are successfully treated (e.g., by surgery to remove the tumor from their brain), Cushing patients' cognitive function and their hippocampal volume return to normal. Furthermore, the incidence of neurodegeneration and dementia in old age among Cushing's patients is not higher than in the general population, suggesting that no permanent damage has been done. This despite the fact that the disease has led to excessive glucocorticoid production sometimes for years, with the highest possible glucocorticoid exposure for a significant portion of their life. If anyone should suffer from glucocorticoid neurotoxicity, this population should certainly be affected! In the light of these findings, some authors have suggested that glucocorticoid exposure represents an insult from which people can recover (Müller et al. 2001). The observed lower hippocampal volumes during the presence of high cortisol levels could be discussed as a consequence of transient intracellular changes in water and electrolyte content (Swaab et al. 2005).

So if it not glucocorticoid toxicity, what else could cause the association between hippocampal volumes and cortisol regulation? An alternative to this model brings neurodevelopmental factors into the focus, and here the picture is perhaps a bit more consistent. There are by now a substantial number of studies which support the idea that distinct events during critical development periods can shape the developing brain, which might in turn influence the personality, and the stress response. Studies looking at pre- and postnatal adversity like malnutrition, toxic exposure, physical or sexual abuse, parental neglect, etc. have shown that these factors can be additive in affecting the volume of key structures in the brain, including the hippocampus, the anterior cingulate, and the precuneus, all structures involved in personality, emotion, and stress regulation (e.g., Engert et al. 2010; Heim et al. 2013). Thus, specific events during critical development periods might determine the development of the brain, which in turn might influence the functioning of key systems, including the stress system.

We could demonstrate partial support for the neurodevelopmental model in a recent study where we first established a link between early-life adversity (in the form of self-reported early-life maternal care), and then showed how the correlation was mediated by the hippocampal volume of the participants. If the size of the hippocampus determines memory contextualization capabilities, this variation could then have personality- and stress-related consequences. The impaired source monitoring would lead to an overgeneralization of the experience of failure and rejection, and consequently to a self-perception of being a failure or being socially rejected in general, which might produce low self-esteem and low locus of control during childhood and adolescence (Davidson et al. 2002; Kernis et al. 1989; Showers 1992). The observed higher cortisol responses would then not be a direct consequence of smaller hippocampal volume, but of the increased stress perception due to consistent unfavorable appraisals of ambiguous situations. Thus, the effect of early-life adversity on the hippocampus would in turn have an effect on the developing personality, which again in turn could then shape the endocrine stress response.

Of course, the question arises why overgeneralization should then not also be an issue for positive life events, in other words, a general lack of source monitoring for both positive and negative life events with no consequences on self-perception. One possible explanation here could be seen in the stress-specific function of the hippocampus within the limbic system. There is evidence that it is specifically the hippocampus together with the anterior cingulate that is involved in the stress response (Sinha et al. 2004). It is also known that the anterior cingulate is particularly involved in error monitoring, which means its involvement is restricted to situations where a mismatch between expectations and reality occurs (Wang et al. 2005). These circumstances would make a specific role of the hippocampus in reaction to negative life events more probable.

The neurodevelopmental model changes the direction of the overall association—both hippocampal volume and personality traits are seen as a consequence of early-life adversity factors, which then in turn determine the cortisol stress response. It would also create a more static association, because variations in current or chronic stress would not result in enduring changes in the brain structure or function. At the same time, the neurodevelopmental model puts a much greater emphasis on the importance of factors in early life, reminiscent of psychoanalytical theories and models. This possibility currently receives increased attention in the literature (Del Giudice et al. 2011). The variations in hippocampal volume as a consequence of critical development periods early in life could then be speculated to have other consequences as well (memory, cognition, executive function), creating a model of developmental trajectory based on critical development periods. Evidence to support the neurodevelopmental model comes from smaller retrospective studies (Engert et al. 2010; Pruessner et al. 2004), but systematic studies on this topic will have to follow to provide broader support such a view.

Taken together, based on our findings to date, we suggest that reduced hippocampal volume might play a role in the development of low self-esteem. This may in turn produce a higher susceptibility to perceive ambiguous situations as threatening, and thus stressful. The idea that hippocampal volume variation might be the cause for adverse functional and behavioral consequences, rather than their consequence has found further support in conjunction with risk factors for developing post-traumatic stress disorder (PTSD), in a study investigating hippocampal volume in twin brothers. Here, in participants who developed PTSD as a consequence of participating in the Vietnam War, the researchers observed lower hippocampal volume compared to participants who went to war, but did not develop PTSD. Intriguingly, however, lower hippocampal volume could also be observed in the PTSD participants' twin brothers—who never went to war—suggesting that the hippocampal volume might be a risk factor for, rather than a consequence of, developing PTSD (Gilbertson et al. 2002).

As mentioned, the possibility that hippocampal volume might play a causal role in the personality/coping interface is supported by the fact that we found consistent results even among relatively young adults. Recently, we have reported on variations in hippocampal volume in young populations (Lupien et al. 2007; Pruessner et al. 2001), suggesting that there is a considerable range of hippocampal volumes present in participants of all ages. At the same time, self-esteem is known to be a stable trait with considerable intraindividual stability throughout life (Markus and Herzog 1991). This supports a model in which variations in brain morphology could become a pathway to certain personality characteristics early in life, but further longitudinal studies are needed to examine these changes over time, and provide validation for these assumed associations.

25.6 Toward Improving Stress Regulation by Modifying Self-Esteem

Notwithstanding the existence of a general tendency toward stability in self-esteem, a strong experimental test of the causal role of self-esteem in the stress response would involve temporarily manipulating levels of self-esteem to examine any impact on the stress response. Parenthetically, this research question touches on a broader issue in the self-esteem literature regarding whether self-esteem can offer any benefits beyond heightened subjective well-being (see, e.g., Baumeister et al. 2003). Our view is that it most certainly can, and we have conducted several studies to test this notion.

Dandeneau and Baldwin (2004) developed an attentional training manipulation in which a participant is shown a grid of 16 people's faces, with 15 of them scowling and only one smiling warmly. The participant's task is to identify as quickly as possible the location of the sole smiling face. The hypothesis was that performing this task over approximately 100 trials would train and facilitate a response of disengaging from the distracting frowning faces, rather than dwelling on them as had been shown to be the normal response of individuals with low self-esteem (Dandeneau and Baldwin 2004). Indeed, this task successfully modified attentional responses, and also boosted participants' scores on standard measures of self-esteem (Baldwin and Dandeneau 2009; Dandeneau and Baldwin 2004; Dandeneau et al. 2007).

In one study that combined this manipulation with a stressful situation, Dandeneau et al. (2007, Study 3a) asked a sample of students to use the attentional training manipulation (or a control task) each day across the week before the final exam in their social psychology course. By the morning of the exam, the group using the find-the-smile task reported lower levels of perceived stress about the exam, less anxiety during the exam, and marginally higher academic self-esteem after the exam compared to controls.

A second study was conducted in a workplace, which can also be a stressful context particularly when—as for telemarketing operators—it is saturated with social evaluation and repeated experiences of rejection and outright hostility. A sample of telemarketers performed the attentional training task (or control) each day before their shift for 1 week. Those undergoing the attentional training showed improved emotional regulation, reporting lower stress levels, and higher self-esteem on daily measures. Cortisol release was assessed five times across the final day of the week, and participants undergoing attentional training had 16.8 % lower cortisol than controls. Moreover, on a measure of cortisol reactivity that examined peak levels of cortisol release, the attentional training group was 35.5 % lower than controls. Finally, the self-esteem boosting training also influenced behavioral self-regulation: By the end of the week, those in the training condition were scoring higher on quality control ratings and also performing significantly better (i.e., making more sales) on the job.

In sum, the Dandeneau et al. (2007) research has confirmed the causal role of self-esteem in the stress response. More specifically, an attentional training task that increased people's self-esteem also led to improved regulation of the physiological aspects of the stress response (including cortisol release, which can have adverse physiological effects). In addition, the attentional training led to improved regulation of behavioral outcomes due to reduced subjective stress and anxiety that might otherwise interfere with performance.

Conclusions

A person's response to stress is known to be linked to a number of psychological variables. A case can be made that specific personality variables, especially self-esteem and locus of control, play a central role in the appraisal of many situations, and thus contribute to the experience of stress. The studies described here provide evidence that participants with low self-esteem and low locus of control tend to show increased and more consistent release of cortisol in response to standardized laboratory stress tests. This effect is observable during stressful experiences, as well as in the failure of the cortisol response to habituate to repeated stress exposure.

We have further shown how this endocrinology/personality link is systematically associated with hippocampal volumes. The hippocampus is an important structure in the formation of memory, emotional regulation, and the regulation of the stress response. Variations in hippocampal volume have been postulated and shown to be systematically linked to HPA axis dysregulation, but intriguingly, the direction of this dysregulation is inconsistent across studies. We conclude that the dysregulation at the psychological level is due, at least in part, to impairments in memory associated with reduced hippocampal function: If specific situational and environmental characteristics associated with negative past events cannot be recalled, this lack of awareness of situational circumstance can lead to an overgeneralization of negative past events, and therefore an increased likelihood to consider the current situations as stressful as well. Thus, poor contextualization mediated by the hippocampus could be linked to abnormal stress responses on the one hand, and lower self-esteem on the other.

Taken together, the research that we have reviewed in this chapter highlights the importance of considering individual differences in self-esteem and locus of control in understanding people's behavioral and endocrinological responses to stress. In this way, our research contributes to a deeper understanding of the biobehavioral foundations of self-regulation.

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