Stress
From a Biological, Social, and Psychological Perspective

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Abstract

Over the years stress has been a term lacking one clear and specific definition. In general, the term stress has been used mostly as an explanation of a response or reaction to a stressor. A stressor can be of both physiological and behavioral character. The experience of stress can occur both due to a real or a perceived stressor. In this literature review, the concept of stress is viewed with insights from biological, psychological, and social perspectives. The stress response is described biologically with the central nervous system (CNS), the brain, and the hypothalamic-pituitary-adrenal (HPA) axis. Social and psychological stress are concepts related to how stress is perceived by the mind and due to social surroundings which is described in relation to social support, self-efficacy, the locus of control and cognitive appraisal. Dealing with stress can be done through coping which refers to the individual capacity to handle a stressor and has generally been divided into two categories, active/passive coping and problem-focused/emotion-focused coping. Depending on the individual resources to cope with a stressor and the ability to decrease the stress response when needed, the long-term effects of stress can therefore vary between individuals. It has been found that positive coping (known as reducing stress) can increase the anterior cingulate cortex (ACC) volume and decrease anxiety and depression. The prefrontal cortex (PFC), the hippocampus, and the amygdala are closely linked to the ACC and affect emotions, learning, and memory related to the stress response.

Keywords: stress, social stress, BPS model, HPA axis, coping, TSST
# Table of contents

1. Introduction............................................................................................................................4

2. The biopsychosocial model of stress..................................................................................6

3. Biological aspects of stress.................................................................................................8
   3.1 The nervous system........................................................................................................9
   3.2 The brain........................................................................................................................10
   3.3 Hypothalamic-pituitary-adrenal axis.............................................................................12
   3.4 Sympatho-adrenal-medullary axis...............................................................................13
   3.5 Effects of biological stress .........................................................................................14

4. Social and psychological aspects of stress ......................................................................16
   4.1 Social support ................................................................................................................17
   4.2 Self-efficacy....................................................................................................................18
   4.3 Locus of control/Theory of planned behavior ............................................................19
   4.4 Cognitive appraisal.......................................................................................................20
   4.5 Trier social stress test....................................................................................................21

5. Coping...................................................................................................................................23
   5.1 Emotion-focused coping vs. problem-focused coping.................................................23
   5.2 Active/proactive vs. passive/reactive coping...............................................................24
   5.3 Ways of coping questionnaire.....................................................................................26
   5.4 The stress-coping model..............................................................................................27
   5.5 Coping and the brain....................................................................................................29

6. Discussion............................................................................................................................31

7. Conclusion............................................................................................................................36

References................................................................................................................................37
1. Introduction

Our everyday-life is filled with situations, thoughts, and feelings that can cause stress. A situation, a thought or a feeling can, therefore, be called a stressor. A stressor can be a challenge or a problem which forces an individual to perform in his actions. If a situation is perceived as stressful or not depends on multiple factors and individual differences (Aneshensel, 1992). Stressors can be of two kinds of character: major life stressors and daily hassles. Major life stressors are linked to changes or disruptions connected to central areas of peoples lives. This can be both choices by individuals or things that happen, e.g. the decision of having a baby or the birth of a baby. Research has shown that events that are uncontrollable and unexpected are especially stressful. Daily hassles are small, day-to-day annoyances or irritation, for example waiting in line or dealing with difficult people. Daily hassles can be very stressful and the combination of many can be as effective as major life changes (Gazzaniga, Heatherton, & Halpern, 2013).

Stress is a term that we hear often and in popular terms stress can be defined as time pressure. People can for example feel stressed when they do not have time to finish or perform a task at a given time. The time pressure often triggers a physiological reaction which can be perceived as being stressed. It is important to note that stress is not equivalent to time pressure in scientific terms. Stress is then a highly individual experience and is not dependent on a particular event but rather on specific psychological determinants that trigger a stress response (Lupien, Maheu, Tu, Fiocco, & Schramek, 2007).

Over the years, the concept and operationalizing of stress has been used in a variety of ways. Stress is often divided into two types, eustress and distress or duress. Eustress is the kind of stress related to positive events, for example preparing for a meeting that you are looking forward to. Distress or duress is the kind of stress related to negative events, for example by studying for an important exam that you have to pass (Gazzaniga et al., 2013).

Research of stress can be traced far back in time and the term stress, aiming at hardship or adversity, can be found as early as in the 14th century. In the 17th century, it seemed to have achieved technical importance by the work of Robert Hooke – a prominent physicist-biologist. Hooke was worried about man-made structures (e.g. bridges) and how they had to be designed to resist forces of nature that could destroy them. He used the term load when referring to the weight of a structure, stress as the area influenced by the load, and strain as the deformation of the structure caused by the interplay of the load and stress. The
Stress – from a biological, social, and psychological perspective

analysis made by Hooke influenced models of stress in the early 20th century in physiology, sociology, and psychology (Lazarus, 1993b). In modern times, the theme that survived was the idea of stress as an “external load or demand on a biological, social, or psychological system” (Lazarus, 1993b, p. 2).

During World War II, interest in an emotional breakdown in response to stresses of combat started to rise with a new perspective. The earlier perspective during World War I had been neurological rather than psychological and the term breakdown had been used as shell shock. Dysfunction was thought to be results of brain damage caused by the sound of exploding shells. But after World War II it became clearer that many conditions in ordinary life (e.g. growing up, marriage, being ill) could produce impact comparable to those of combat. This meant a growing interest in stress as a cause of human dysfunction and distress (Lazarus, 1993b).

The term stress can be traced to more than one definition or operationalization, therefore stress is a term that has been used to aim at different meanings by various people. During the years, descriptions of stress have been many and varying. Oken, Chamine, and Wakeland (2015) used the term stress to describe responses to stressors that can be both physiological and behavioral. They also claimed that the brain is the key organ responsible for interpreting what is stressful to an individual. Lloyd, King, and Chenoweth, (2002) define stress as an emotional and physiological reaction to a stressor. A stressor can be a demand, a circumstance, or a situation which disrupts a persons inner balance and initiates the stress response due to increased autonomic arousal.

The Oxford Dictionaries defines the word stress as “Pressure or tension exerted on material object”, “A state of mental or emotional strain or tension resulting from adverse or demanding circumstances”, or “Particular emphasis or importance” (“Stress”, 2017b). The Cambridge dictionary defines stress as “Great worry caused by a difficult situation, or something that causes this condition” (“Stress”, 2017a). McEwen and Gianaros (2010) describe stress as a transactional process that arises from real or perceived environmental demands, which can be appraised as threatening or advantageous depending on the adaptive coping resources that are available for an individual. The stress process affects the health and can be labeled as “good”, “tolerable” or “toxic”. The label depends on the degree to which the individual perceives control over a given stressor and the resources and support for handling the stressor.

This literature review aims at giving a brief overview of the concept of stress. The first
focus will be to describe stress from a biological perspective and to describe what happens in
the brain and the body during stress. The second focus concerns the social and psychological
perspective of stress and how it affects the mind. Lastly, the focus will be on coping with
stress and how dealing with stress can affect the brain, the mind, and the body.

This thesis will not review individual and personal differences, but it will be shortly
mentioned in the sections about social and psychological stress and coping. The effects of
personality or sex differences will not be fully described due to its complex field which fits
better in the field of social psychology than the field of cognitive neuroscience.

The review will begin with an introduction to the biopsychosocial (BPS) model of
stress since this model explains how biological, social, and psychological aspects interacts
and affects the health and well-being. The biological aspects of stress, for example the CNS
and the HPA axis, will be described to clarify what happens in the body and the brain during
stress. The second section focuses on the social and psychological aspects of stress and how
stress affects the mind. Concepts that are described here are self-efficacy, the locus of control,
and cognitive appraisal. The last section focuses on coping, dealing with stress and different
coping strategies. This part will also explain effects of coping, stress, and its impact on the
brain.

In this thesis, the term stress will be referred to as an emotional and physiological
reaction to a stressor. The concept of stress will therefore be viewed with insights from
biological, psychological, and social aspects of stress.

2. The biopsychosocial model of stress

In 1977, George Engel wanted to illuminate that the traditional biomedical model of
stress used the biological indices as the most valuable criteria to define a disease. Engel
(1977) meant that this could lead to those people who felt sick could do so without showing
biologically that they were sick and that they therefore would not be classified as being sick.
People that at the same time felt well but biologically showed that they were sick could
therefore be classified as being sick. Engel (1977) introduced the BPS model of stress, a
model that would also include psychological and social factors along with the biological
factors when looking at a disease. This model made it possible to explain why “illness”
conditions are experienced only by some individuals and that it might depend on the relation
to the personal emotional reaction, life circumstances, or somatic symptoms (Engel, 1977).
Rith-Najarian, McLaughlin, Sheridan, and Nock (2014) describes the BPS model of stress as a framework which links cognitive, behavioral, and physiological responses to stress and performance. The BPS model of stress presents that during an acute stressor, the situation is first perceived and appraised by the individual as to which personal resources the individual holds against which demands are needed to successfully master the situation. The appraisal then influences the physiological response which in turn affects the performance of the individual and how well he deals with the situation. When the stressful situation is starting to end, the factors together create a stress-appraisal that contains an opinion of how stressful the situation was.

Furthermore, Suls and Rothman (2004) state that well-being and physical health evolves through biological, physiological, and social factors that interact. According to Drossman (1998) the BPS model of stress can be helpful when shifting focus and looking at medical conditions in a new way. By distinguishing the difference between illness and disease and at the same time adding psychosocial factors, the BPS model of stress can be viewed as a construction for the multidisciplinary research.

Gazzaniga et al. (2013) describe the BPS model of stress by viewing health and illness as a circle. The circle is a combination of biological characteristics (e.g. genetic predisposition, the brain, and the nervous system), behavioral factors (psychological factors like thoughts or actions, personal lifestyle, or health beliefs), and social conditions (social support, family relationships, environments, cultural influences). Thoughts and actions affect the environment that we choose to interact with, the environment then affects the biological underpinnings of our thoughts and actions.

An example of how the BPS model works is when an individual often is anxious due to genes (biological factor), the individual then eats comfort foods like ice cream, macaroni, and cheese to reduce the feelings of anxiety (psychological factor). Consuming this kind of food frequently might cause the person to gain weight and become overweight. Overweight people often do not find it pleasant going to the gym though exercising can be hard and other people at the gym might stare (social factor). By not going to the gym the individual risks to gain even more weight which affects the body (biological factor) and the circle would then repeat. All these factors would then affect feelings, emotions and bodily reactions to stress (Gazzaniga et al., 2013).

In figure 1, the BPS model of stress is illustrated as a circle around the concept of stress and how biological, social, and psychological aspects together affect the experience of
According to Borrell-Carrió, Suchman, and Epstein (2004) the BPS model of stress can be used to understand how struggles like illness, suffering, and disease are affected by a multi-level organization from the molecular to a societal view. The BPS model of stress is practically a method for understanding a patients subjective experience as an important part of providing a thorough diagnosis and follow-up of the health outcome.

3. Biological aspects of stress

There are constantly a lot of internal processes going on to keep the human body alive. To explain what happens in the body, two approaches have been used. The first approach gives emphasis to the purpose of the bodily process, why something happens in the body. The second approach gives emphasis to the underlying mechanisms as to where and how the process occurs (Sherwood, 2015).

Homeostasis is a term referring to the stability of the physiological systems that maintain human life (McEwen, 2007). Homo can be translated to the same and stasis to stay or stand (Sherwood, 2015). It is a complex, harmonious, and dynamic balance that affects the survival of a living organism (Chrousos & Gold, 1992). The homeostatic system includes blood oxygen, blood pH, and body temperature which must be maintained at short intervals (McEwen, 1998). The homeostasis is constantly challenged and sometimes threatened by external- or internal stressors and disturbing forces. Homeostasis is then reestablished by adaptational responses. Adaptational responses consist of an extraordinary range of mental or physical reactions that attempt to counteract the effects of the stressors (Chrousos & Gold, 1992).

Allostasis is a term referring to the process of changing parameters by the internal milieu of an organism, this is to maintain physiological stability by matching the parameters appropriate to the environmental demands (Juster, McEwen, & Lupien, 2010). The term was introduced by Sterling and Eyer in 1988 to characterize how blood pressure and heart rate
vary with experiences and time of day (Sterling & Eyer, 1988). Allostasis is used as a term for a physiological coping mechanism, a process to keep the organism alive and functioning (McEwen, 2000). Allostatic load is consequently the ‘wear and tear’ the body experiences due to repeated allostatic responses that have been activated during stressful situations (Juster et al., 2010).

The allostatic systems make it possible for us to respond to our physical states (e.g. exercising, standing, being awake, being asleep) and to cope with hunger, danger, extremes of temperature, and different types of infections. When faced with a challenge like an infection, a dangerous situation or a public-speaking test, the core response of the body is twofold. This means that an allostatic response is turned on which begins with a complex adaptive pathway and when the threat has passed the response is shut down. The sympathetic nervous system (SNS) and the HPA axis are both involved in the most common allostatic responses (McEwen, 1998).

When the allostatic systems are activated and not automatically shut down as it should, the system is constantly working which might be described as stress. The stress response is a natural response to save humans from threats that can be dangerous. The stress response itself can then be dangerous if the allostatic systems are not shut down when there is no longer an existing threat (Juster et al., 2010).

Stress can be intensively felt during a shorter period of time and can be felt less intense during a longer period of time. The two types of experienced stress are generally divided into acute and chronic stress. Acute stress has been related to the fight-or-flight response or major life events, such as the birth of a baby, whereas chronic stress can be related to a load of minor day to day stresses, such as keeping up with deadlines (McEwen, 1998).

The field of psychoneuroimmunology aims at studying the immune system of the body through psychological variables. Over 300 studies have demonstrated that short-term stress boosts the immune system while chronic stress weakens the immune system and leaves the body with less ability to deal with infections (Gazzaniga et al., 2013).

3.1 The nervous system

Information from the external environment is picked up by the nervous system. The nervous system is a complex network sending and receiving messages through the nerves and cells in the body and the brain (Sherwood, 2015).
Gazzaniga, Ivry, and Mangun (2009) describe the nervous system as two subdivisions: the CNS, which comprises the brain and spinal cord, and the peripheral nervous system (PNS) which comprises everything outside the CNS. The CNS can therefore be thought of as the main controller of the nervous system. The PNS delivers sensory information to the CNS and sends motor commands from the CNS to the muscles to control both the voluntary muscles of the body and the smooth muscles, the heart, and the glands involuntary activities (Gazzaniga et al., 2009).

The steroid hormone cortisol is involved in learning, memory, and emotion. It plays, therefore, a key role in the CNS. It regulates both blood sugar (known as glucose) storage and utilization in the metabolic system and regulates the maturation of a subtype of white blood cells called lymphocytes and the magnitude and duration of the inflammatory responses in the immune system (Miller, Chen, & Zhou, 2007).

A part of the PNS is the autonomic nervous system (ANS) which participates in controlling the action of smooth muscles, various glands, and the heart. It is divided into two branches, the SNS and the parasympathetic nervous systems (Gazzaniga et al., 2009). The sympathetic system uses a neurotransmitter called norepinephrine whereas the parasympathetic system uses the neurotransmitter called acetylcholine. Activation of the SNS increases heart rate and prepares the body for making an action. This action is mostly known as the fight-or-flight response and is released by stimulation of the adrenal glands which in turn releases the stress hormone known as adrenaline. Unlike the SNS, when the parasympathetic nervous system is activated, the heart rate slows down and the digestion is stimulated. In general, the parasympathetic nervous system can help the body with normal functions that are relevant to maintain the homeostasis of the body (Gazzaniga et al., 2009). In table 1, the difference between the SNS and the parasympathetic nervous system is shown.

<table>
<thead>
<tr>
<th>Sympathetic nervous system</th>
<th>Parasympathetic nervous system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhibits salivation</td>
<td>Increases salivation</td>
</tr>
<tr>
<td>Accelerates heart</td>
<td>Slows heart</td>
</tr>
<tr>
<td>Less rapidly breath</td>
<td>More rapidly breath</td>
</tr>
<tr>
<td>Decreases digestive functions</td>
<td>Increases digestive functions</td>
</tr>
</tbody>
</table>

Table 1. Characteristics of the sympathetic nervous system vs. the parasympathetic nervous system

3.2 The brain

The brain perceives potential threats and determines both behavioral and physiological responses which makes it the central organ of stress and adaptation to stressors (McEwen,
The brain can usually be seen and divided into four lobes which are the frontal lobe, the parietal lobe, the occipital lobe, and the temporal lobe. The frontal lobe is involved in cognitive control, planning, and execution of movements. The parietal lobe is involved in receiving sensory inputs about temperature, touch, limbic position, and pain which is useful when coordinating an action. The occipital lobe is responsible for processing visual information and the temporal lobe is involved in processing visual, auditory, and multimodal information (Gazzaniga et al., 2009).

In the temporal lobe contiguous to another are called the hippocampus the amygdala is located, which consists of comprised distinct cell-groups. The hippocampus plays a key role in processing memory (Gazzaniga et al., 2009). In a stress-related process, the amygdala involves a rapid emotional and behavioral response due to a stressful event. The response is based on integrating multimodal sensory inputs from thalamic, cortical, and brainstem afferent relays. The central nucleus of the amygdala communicates with areas of the PFC in the frontal lobe (including the ACC), the ventromedial PFC, and the orbitofrontal cortex (OFC) that also is involved in stressor-related processing (Roozendaal, McEwen, & Chattarji, 2009). According to McEwen (2007) the amygdala supports and coordinates the changes in peripheral physiological reactivity evoked by stressors, which seems to be related to adverse social environments.

The PFC is involved in higher cognitive functions (e.g. executive control and working memory) and occupies the anterior portion of the frontal lobes. The PFC is active in the top-down regulation of threat-related and stress-related responses but also during coping-processes that are mediated by subcortical limbic areas which include the hippocampus, the hypothalamus, and the amygdala (Compas, 2006). A number of prefrontal areas send projections to the hypothalamus (and other regions) for regulating the peripheral stress response axes that are important for health, primarily the OFC, the dorsal medial PFC, and the ACC (McEwen & Gianaros, 2010).

Being exposed to various stressful experiences can reduce a number of immune
functions. Circulating levels of immunological cell classes (called lymphocytes) can be diminished by stressful life experiences such as losing a job or taking an exam (Kemeny, 2003).

3.3 Hypothalamic-pituitary-adrenal axis

One of the key mechanisms of the HPA system is to support an organism to adapt to physical and psychosocial changes in the environment (Burke, Davis, Otte, & Mohr, 2005). It is a discrete set of releasing-hormones that control the HPA axis. This set is located in the medial parvocellular division of the hypothalamic paraventricular nucleus (PVN). These hormones secrete and synthesize corticotrophin-releasing hormone (CRH) which is the primary substance promoting secretion of adrenocorticotropic hormone (ACTH). ACTH travels to the anterior pituitary and is released into the systemic circulation. When ACTH is bound in the adrenal cortex, steroid hormones (also known as glucocorticoids) are released and synthesized (Herman, Ostrander, Mueller, & Figueiredo, 2005). This process is pictured and described in figure 3.

![Figure 3. The HPA axis. Adapted and reworked from Gazzaniga et al. (2013). a.) Stress begins with a stressful event, which might be an upcoming exam, going to the dentist or a stack of unpaid bills. b.) This stressful event is then perceived by various brain areas. c.) The hypothalamus (located in the center of the brain) is then sending a chemical message to the pituitary gland (a major gland just below the brain). The pituitary gland is secreting a hormone called ACTH which is traveling through the bloodstream and might reach the adrenal glands (which can be found near the kidneys). The adrenal glands secrete a steroid hormone known as cortisol.](image)

The end-product of the HPA axis is steroid hormones (glucocorticoids), the most known steroid hormone is cortisol. Steroid hormones are important in growth processes, energy metabolism, immune function, neuroendocrine control, and brain functions such as memory and learning processes. The HPA axis is highly sensitive to the disturbances of the external environment because the glucocorticoid responses can get started by a direct activation of the PVN (Herman et al., 2005). When cortisol is secreted, the amount of glucose is increased in the bloodstream. Norepinephrine and epinephrine are released by the adrenal glands and activates the SNS, increasing heart rate and blood pressure. The body can, due to
these activations, prepare for a response to the stressor (Gazzaniga et al., 2013).

When the HPA axis is chronically over-activated it elicits a domino effect on the biological systems. These systems might then collapse themselves which can lead the organism to be susceptible to stress-related diseases (Juster et al., 2010). The hypo-activity of the HPA axis can for example be observed in patients with post-traumatic stress disorder or muscle and tissue pain (also known as fibromyalgia). The HPA axis can also be seen as hyperactive in association with for example a major depression or Alzheimer's disease. Hyperactivity can be characterized by a higher level of corticosteroid hormones and a less effective level of the PVN and the pituitary, which is generated by a feedback action (Joels, Verkuyl, & van Riel, 2003).

Joels et al. (2003) mentions one theory for this constant hyperactivity of the axis saying that the hyperactivity is caused by a gradual change of neuronal inputs to the PVN that might cut off the CRH-producing cells after being exposed to long-standing stress. These cells then receive inputs from gamma-aminobutyric acid known as GABA (Joels et al., 2003), which is the inhibitory neurotransmitter manager in the CNS according to Gazzaniga et al. (2009).

3.4 Sympatho-adrenal-medullary axis

Since the HPA axis is generating a long-term and more chronic response, the sympatho-adrenal-medullary (SAM) axis is associated with short-term and acute responses. The SAM axis and the HPA axis complement each other but represent different aspects of the individual response to stress. Both the HPA axis and the SAM axis are induced by the hypothalamus. The sensory inputs and the feedback mechanisms of the axes oversee both the level of the environmental demand and the internal state of the organism (Bitsika, Sharpley, Sweeney, & McFarlane, 2014).

The SAM axis acts fast via the SNS branch of the ANS in response to stressors, which generates a neurally instigated response in target organs such as the heart or the skin. It does so by a direct nerve stimulation from the hypothalamus and with support from adrenaline which is produced by the adrenal medulla. The effects of the SAM axis results in an increased sweating of the feet and the palms, an increased heart rate, enlargement of the pupils, an increase in blood flow, and an increased oxygen uptake in the lungs. When comparing the HPA axis and the SAM axis, the SAM axis responds via nerves whereas the HPA axis responds via hormones which makes the SAM axis faster in responding to stressors than the
3.5 Effects of biological stress

Stress hormones are indispensable to the normal health, but can over a long-term have a negative effect on the health. Both the immune system and the body is affected and altered by stress hormones. Problems such as cardiac disease, diabetes, increased blood pressure, and a decline in sexual interest can also be linked to stress hormones (Gazzaniga et al., 2013).

A stressful experience can include major life events, trauma, or abuse and can be related to the home-, workplace-, or neighborhood environment. Both acute and chronic stress can have long-term consequences on health and the effects of chronic stress can be made worse by a rich diet and the use of alcohol and tobacco but can also be reduced by moderate exercise (McEwen, 1998). The ability to habituate or adjust to repeated stress determines how the individual perceives a situation. For many people it can be a challenge to speak in public but after some training, most people become more familiar with public speaking and their cortisol secretion that earlier increased when facing this challenge would no longer increase as much as before (McEwen, 1998).

When the SNS and HPA axis is activated, catecholamine (hormones produced by the adrenal glands) is released from nerves and the adrenal medulla which leads to a secretion of corticotropin from the pituitary. The release of cortisol from the adrenal cortex is then mediated by the corticotropin. When for example the danger is over or the infection is contained these systems are inactivated and cortisol and catecholamine secretion return to baseline levels. If the inactivation is not efficient it will be an overexposure to stress hormones. An increased secretion of stress hormones over weeks, months, or years can result in an allostatic load and related pathophysiologic consequences (McEwen, 1998).

Stress hormones can change the structure of neurons in the brain and then modulate different functions. One of the most sensitive and plastic regions in the brain is the hippocampus, which serves important cognitive functions connected to the memory (McEwen, 1998). The hippocampus is located in the medial temporal lobe and is involved in remembering and learning spatial and declarative information, it regulates visceral functions (HPA axis included) and process contextual aspects of emotional events. Studies about the hippocampus using animal models have revealed that repeated stress can cause a remodeling of hippocampal circuitry, for example loss of spine synapses, shortening of dendrites, and suppression of the neurogenesis ongoing in the dentate gyrus region of the hippocampal
formation (McEwen & Gianaros, 2010). Neurogenesis is a process when old and dying neurons are replaced by new neurons in structures that are still growing (Øverli et al., 2007). The hippocampus both supports aspects of memory and regulates the HPA activity impairment and can be expected to have two effects: (1) Impairment of hippocampal involvement in declarative, episodic, contextual, and spatial memory may lead to a weakening of an individuals ability to process information in new situations and in making decisions regarding how to handle new challenges. (2) Impairment in regulating HPA activity and turning off the stress response, which can lead to an elevated HPA activity and exacerbate actions of adrenal steroids in the long-term as effects of repeated stress (McEwen & Gianaros, 2010).

As a result of repeated stress, animal studies of the PFC reveal changes in neuronal structure and connectivity. The medial PFC has shown a loss of synaptic connections and reduced neuronal complexity while the OFC has shown a greater neuronal complexity due to chronic stress (McEwen & Gianaros, 2010).

Lehman, Rodin, McEwen, and Brinton (1991) studied the impact of chronic environmental stress in a bio-breeding rat (an animal model for human autoimmune insulin-dependent diabetes mellitus). In a design to model chronic moderate stress, the animals received a triad of stressors over a 14 week period. The animals varied with an age from 25 to 130 days and was weighed and tested for glycosuria (secretion of glucose into the urine) two times per week. Blood sampling was performed once a week. On the basis of weight loss, 2+ glycosuria, and blood glucose levels of 250+ mg/dl diabetes was diagnosed. It was found that in the bio-breeding rat, chronic stress increased the extent of the gene for Type 1 diabetes in the phenotypic expression.

In summary: The biological aspects of stress describes what happens in the body during stress, how it cooperates with it and how it affects the nerve system and the brain. The function of the stress response is to help humans manage a challenge or a threat. The response is mainly activated by the HPA axis or the SAM axis in cooperation with the nerve system and the brain. Stress is not harmful to the body if the stress response is shut down after the challenge, but rather when the internal stress systems are still highly activated if they should be at rest. This chronic activation of the stress systems can for example lead to cardiac diseases, diabetes, or impaired memory.
4. Social and psychological aspects of stress

Kemeny (2003) argues that the way an individual thinks about a specific stressful situation might affect the outcome of the experience. Gianaros and Wager (2015) explain that psychological stress may occur due to appraisal processes that can be experienced as a threat that cannot be handled by the own ability to cope with the situation or a thought caused by the threat. The appraisal systems contain a part of a linking pathway between psychological stress and health-related physiology.

A psychological definition of stress has closely coupled appraised stress with loss of self-esteem and feelings of helplessness (Cohen & Wills, 1985). These feelings arise due to a perceived inability to cope with situations that demand an effective response. The loss of self-esteem might occur due to failure to cope appropriately, which is attributed to a persons own capacity and/or stable personality traits. Self-esteem refers to the individual and the internal communication that a person is valued for his own worth and despite difficulties or personal faults, he is accepted. Supporting self-esteem has been termed emotional support, expressive support, ventilation or close support. Informational support is when helping defining, understanding, or coping with events perceived as problematic. This type of support has also been named advice, appraisal support or cognitive guidance.

Aneshensel (1992) views social stress as an occurrence due to inevitable consequences of social organization. Ordinary people often experience a stressful life and the emotions that follow, this might be due to that people tries to integrate into the normative structures of society. Turner, Wheaton, and Lloyd (1995) argue that social stress can be seen as a “buffer” because of oppositional indirect effects via resources that direct its effects and the total causal effect is reduced.

Blanchard, McKittrick, and Blanchard's (2001) animal models of social stress involve a subject animal being intermittent, chronic, or single exposed to a conspecific. In the laboratory, different social stress situations are used, involving two or more animals in dyadic, group, or colony situations. In research with animal models, social stress has led to a variety of behavioral changes, mostly involving emotionality linked behaviors like defensiveness and anxiety but also social and sexual behaviors. It has been shown that chronic social stress has altered the morphology of hippocampal neurons which may affect learning and memory processes.

When spending time with others in recreational activities and leisure it is known as social companionship and may reduce stress by filling the need for contact with others and at
the same time distracting the person from worrying about problems and encouraging positive affect moods. This can also be known as diffuse support or belongingness. At last, there is instrumental support referring to financial aid, need services, and material resources that may help reduce stress by a direct resolution of instrumental problems (Cohen & Wills, 1985).

4.1 Social support

Social support can be closely linked to basic social needs such as affection, approval, esteem, belonging, identity, and security. It can also be interpreted as being satisfied due to interactions with others (Aneshensel, 1992). Social stress can according to Aneshensel (1992) arise due to a lack of stable social organization surrounding the individual.

Social bonds are important for survival for many of the social species, thus social disconnection may be experienced as a fundamental survival threat (Eisenberger & Cole, 2012). Signaling cues that one's connections are damaged or threatened might activate a basic neural alarm system, which is responsible to detect and elicit adaptive responses to threatening harm or danger. The neural alarm system includes various brain areas like the amygdala (in the temporal lobes), known for its role in responses related to threats, along with the dorsal ACC (dACC), the anterior insula, and the periaqueductal gray (PAG), known for their roles in processes related to threat and pain. These regions can activate endocrine and autonomic responses generating implications for health (Eisenberger & Cole, 2012).

Seeking social support increases positive effects and can be associated with lower heart rate, lower blood pressure, lower catecholamine levels, more use of coping strategies, and a better immune functioning, which seems to be linked to a reduced neuroendocrine reactivity (Olff, Langeland, & Gersons, 2005).

Several studies have found evidence for a linkage between social support and well-being. The benefits of social support on well-being can be seen through two different processes (Cohen & Wills, 1985). One model, termed the buffering model proposes that social support is only related to well-being for people during stress and that the support “buffers” or protects the person from the stressful event and it is a potentially pathogenic influence. In comparison, another model called the main-effect model proposes that irrespective of being under stress or not, social resources have a beneficial effect. Evidence for this model comes from a demonstration of a statistical main-effect of support with: no Stress X Support interaction. Evidence for the buffering model has been found when social support measure assesses interpersonal resources, responsive to the needs elicited by stressful events. Evidence
for a main-effect model was found when support measure assesses a persons degree of interaction in a large community social network (Cohen & Wills, 1985).

In a study by Kirschbaum, Klauer, Filipp, and Hellhammer (1995) social support was measured through the cortisol response to the Trier Social Stress Test (TSST) (which is described later in this section). Healthy adults (N=66) received either “no support” or “social support” from either an opposite-sex “stranger” or “partner”. The support providers were asked to show supportive behaviors during the preparation of a speech. In the “stranger” condition, two male and two female graduate students of psychology were trained in theory (emotional and instrumental support modes and ineffective support attempts) and applied social support to the person being exposed to the stressor (public speech) 1 week before the first experimental session. In the “partner” condition, the partners’ task during the experiment was to be as helpful as possible during the preparation of the speech. Saliva samples were obtained from each subject (-3min, +10min, +20min, +30min, +40min, +50min) but showed no statistical significance in the difference in baseline cortisol levels between the groups. ANOVA results indicated significant results for the cortisol response for the group by sex effect ($F = 4.0, p = .023$) suggesting that there is a difference in cortisol responses between gender in the experimental groups (Kirschbaum et al., 1995).

4.2 Self-efficacy

Bandura (1991) describes perceived self-efficacy as “peoples beliefs about their capabilities to exercise control over their own level of functioning and over events that affect their lives” (Bandura, 1991, p. 257). Perceived behavioral control, on the other hand, focuses on the ability to perform a particular behavior (Ajzen, 2002).

Perceived self-efficacy gets influence from four major processes including cognitive, motivational, affective, and selection processes. Cognitive processes refers to the human behavior that is mostly performed with purposes and regulated by cognized goals. A strong perceived self-efficacy makes people set higher personal goals for themselves and gives them a stronger commitment to achieve their goals. People with a high sense of efficacy see success forward while those who doubt their efficacy see failure forward and complain about all that can go wrong. Affective processes explains how a persons belief in his own capabilities affect how much stress and depression he experiences in threatening or difficult situations and also how it affects his level of motivation, which can be seen as the emotional mediator of self-efficacy belief (Bandura, 1993).
In anxiety arousal, perceived efficacy to exercise control over stressors plays a central role. Those who believe that they can manage threats do not come up with disturbing thought patterns whereas people who believe they cannot handle these threats experience high anxiety arousal and dwell on their coping absence. They might also think about and worry about threats that rarely occur. This way of thinking leads them to distress and deteriorates their level of functioning (Bandura, 1993).

When people who distrust their self-efficacy try to cope with threats their stress mounts, their blood pressure rises, their heart rate accelerates, their stress-related hormones are activated, and they suffer a reduction in immune function. When their coping efficacy has been strengthened by life experiences the same thought pattern can be handled without these stress reactions (Bandura, 1993). A low sense of self-efficacy can produce both depression and anxiety. One route to depression is a low sense of social efficacy. The harmful effects of chronic stressors can be reduced by being socially effective, by seeking out and cultivating social relationships, and by using models on how to manage difficult situations. Perceived self-efficacy opens up for social support, brings satisfaction to peoples lives, and leaves beneficial effects on psychological well-being and functioning (Bandura, 1993).

4.3 Locus of control/Theory of planned behavior

When studying human action, the theory of planned behavior has emerged as an influential and popular conceptual framework (Ajzen, 2002). According to the theory, the human behavior is guided by three sorts of considerations: behavioral beliefs (beliefs about consequences or attributes likely to affect the behavior), normative beliefs (beliefs about other people in relation to normative expectations), and control beliefs (beliefs about attending factors that might reduce or enhance the performance of the behavior). Behavioral beliefs produce a favorable or unfavorable attitude towards the behavior whereas normative beliefs give rise to a subjective norm or perceived social pressure. Control beliefs result in perceived behavioral control evaluating the ease or difficulty of performing the behavior (Ajzen, 2002).

Many factors can affect the performance of a behavior both in a positive and a negative way. Some factors (including willpower and skills) are internal to the individual while other factors (such as demands or actions of other people) are external. Distinguishing between internal and external causes of a behavior can be important (Ajzen, 2002). The responsibility for failure or success is attributed to the actor when it is perceived as internal factors (effort or ability) whereas when it is perceived as due to external factors (luck or task
difficulty) it is perceived with less responsibility (Weiner & Kukla, 1970). The internal and external locus of control has many times been confused with the control or the lack of control over the performance of the behavior, this confusion might be due to the concept of perceived locus of control (Rotter, 1966). The concept of perceived locus of control refers to that people differ in how they view rewards, punishments, or events in their lives caused by their behavior, their actions, and by factors beyond the individual control (Rotter, 1966).

4.4 Cognitive appraisal

To deal with a stressful experience and to effectively deal with a stressor humans use the cognitive appraisal to link thoughts with feelings. Cognitive appraisals help to more objectively think about and manage feelings (Gazzaniga et al., 2013). Appraisal systems are used to distinguish and assess memories, thoughts, and situations in life based on how meaningful and important they are for the individual. It has been thought that appraisals associated with threats to social, physical, and personal well-being bring forth psychological stress in cases where the own coping ability is exceeded (Gianaros & Wager, 2015).

Cognitive appraisal is a process when a situation is categorized in terms of its significance for well-being (Lazarus & Folkman, 1984). Though appraisal is the individuals own view of the situation, it can be seen as an essentially subjective concept (Cohen & Wills, 1985). According to Lazarus (1993b) appraisals can be conceptualized and divided into a two-part process known as primary- and secondary appraisals. Primary appraisals are used to decide whether a stimulus is benign, stressful, or irrelevant. Carver, Scheier, and Weintraub (1989) describes it as the first part of the process where someone discovers the threat. Secondary appraisals is the part of the process when a potential response to the threat is brought into mind. Lazarus (1993b) refer this part of the process as to when someone evaluates different response options to further be able to decide how to handle the threat.

According to Frankenhaeuser and Lundberg (1985) negative appraisals of stressors leads to the release of cortisol which may increase the vulnerability to depression. Cortisol is not released until a situation is perceived as harmful and the cognitive ability to evaluate the event is a key function in the bodily response to a threat. How extensive the neuroendocrine stress response becomes depends on whether the stressor is appraised as a challenge or a threat. Challenge appraisals can be associated with the fight-or-flight response-pattern, distinguished as short-term increases in catecholamines and cortisol adaptation when similar stressors are faced over time. The challenge response has been associated with low negative
emotion, enhanced coping ability, and a stronger cardiac activity. In comparison, threat appraisals have been associated with high negative emotion, poorer coping, higher reactive levels of cortisol, and an increase in peripheral vascular resistance (Frankenhaeuser & Lundberg, 1985).

Perceived behavioral control and self-efficacy are in a way quite similar, they are both concerned with the perception of the ability to perform a behavior or a sequence/series of behaviors (Ajzen, 2002). Discussions of control over the performance of a behavior with internal locus and lack of control with external locus lie close to the concept of self-efficacy and controllability. The belief of self-efficacy are reflecting internal factors whereas the controllability of behavior can be dealt with external factors (Ajzen, 2002).

4.5 Trier social stress test

When looking at the biological aspects of stress, one of the most commonly used methods has been to analyze the response of the HPA axis and the CNS when describing stress reactions, though these biological responses is also activated during perceived psychosocial stress. To test for psychosocial stress, the TSST was developed by Clemens Kirschbaum and colleagues at the University of Trier in 1993 (Kirschbaum, Pirke, & Hellhammer, 1993).

To study an individuals HPA axis response pattern to psychosocial stress, a laboratory stress paradigm was needed to be able to test if the majority of the subjects were potent enough to induce significant changes of cardiovascular and endocrine parameters (Kudielka, Hellhammer, & Kirschbaum, 2007). The neurobiological stress response in humans had to be induced by a reliable and valid stressor which under experimentally controlled conditions would induce the stress response (Allen et al., 2017).

The TSST and the stress protocol has been used both in healthy and clinical subjects and populations, investigating variables from subjective-verbal stress reports to objective behavioral and biological stress responses that include parameters of the HPA axis, the SAM axis, the cardiovascular system, the immunological system, and the blood coagulation system (Kudielka et al., 2007). The test is ecologically valid and based on stress induced by public speaking. It integrates unpredictability and social evaluation by forcing the individual to speak towards an audience that will not respond and then complete a surprise arithmetic test (Allen et al., 2017).

The TSST is a performance task that consists of a brief preparation period (3 min)
following a test period. The participant has to deliver a free speech (5 min) and has to perform mental arithmetic (5 min) facing an audience. Before the test begins there should be a rest period of at least 30-45 minutes so that effects of prior potentially stressful events or other effects that might affect the measures is minimized. The participant is asked to go for a personal interview with the staff managers of a company to apply for a job. The subject is told that after a preparation time he will introduce him/herself to the committee in a free speech to convince them that he is the best applicant for the job. After the speech, the committee might ask supplementary questions and later present another task. The participant is also told that his presentation will be taped- and video recorded for later analysis by a voice frequency analysis of nonverbal behavior and video analysis (Kudielka et al., 2007).

The committee is trained to communicate in an unresponsive and neutral manner with the participant and gives no facial or verbal feedback. The preparation is done at a small table in front of the committee but the written paper is not allowed to be used during the speech. After the speech and questions, the committee asks the participant to serially subtract the number 17 from 2023 as accurately and fast as possible. Every time the participant makes a mistake one member of the committee interferes by telling the person to stop and start over at 2023. After the session the participant is being told the goal of the study and that there was no tape- and video recording during the speech (Kudielka et al., 2007).

During the years, the TSST has been used in hundreds of studies aimed at examining how the human neurobiology is influenced by acute stress. The TSST has according to Allen et al. (2017) led to a procedure that is now considered a golden standard in human experimental stress research and a pillar in stress laboratories worldwide though it combines “the key elements of social evaluative threat and uncontrollability to produce a consistent and robust physiological and psychological stress response in humans” (Allen et al., 2017, p. 115).

In summary: Social stress is mostly expressed when feelings of belongingness are lacking. How social stress takes form depends on various factors and individuality, it can for example depend on how the stressor is perceived, if it can be controlled, and how it is appraised. Social support can for example improve self-esteem and reduce feelings that can cause social stress. One of the most commonly used methods to measure social stress is by using the TSST.
5. Coping

Pearlin and Schooler (1978) conceptualizes coping as to what one does to avoid being harmed by strains in life. According to Folkman and Lazarus (1985) coping is defined as cognitive and behavioral efforts for mastering, tolerating, and reducing external and internal conflicts and demands. Coping as a process has been defined by Lazarus (1993a) as “ongoing cognitive and behavioral efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person” (Lazarus, 1993a, p. 237).

In 1966 the main interest concerning how people cope with stress became stronger when Richard Lazarus claimed that the process of stress consisted of three parts (Lazarus, 1966). As described in the section about cognitive appraisals, the first and second part of the process was called primary- and secondary appraisals. The last part of the process was called coping and referred to when the response to the threat was executed (Carver et al., 1989).

Coping has also been defined as a constantly changing cognitive and behavioral effort by a person who is trying to manage specific internal and/or external demands valued as difficult or overwhelming (Folkman, Lazarus, Dunkel-Schetter, DeLongis, & Gruen, 1986). Generally coping has been viewed as two major functions which can be divided into two kinds of coping, the emotion-focused coping and the problem-focused coping. Emotion-focused coping refers to regulating stressful emotions whereas problem-focused coping refers to altering the trouble that causes the distress. Coping can therefore be neither good nor bad but rather depend on the persons efforts to manage demands (Folkman et al., 1986).

Pearlin and Schooler (1978) states that before studying coping a distinction between social resources, psychological resources, and specific coping responses must be made. They refer to resources as to what people have available when developing coping characteristics and not to specify what they do. Social resources are different kinds of interpersonal networks that people belong to and can have support from e.g. family, friends, neighbors, and co-workers. Psychological resources are referred to as personality characteristics that people use to help them resist the threats of events and objects that occur in their surroundings (Pearlin & Schooler, 1978). Coping behavior and its efficacy can also be seen as situation-specific, which indicates that a belief in personal control may sometimes be more damaging than helping, particularly when the stressors cannot be controlled (Aneshensel, 1992).

5.1 Emotion-focused coping vs. problem-focused coping

Coping efforts have at a human level been argued as either problem-solving or
emotion-focused (Maier & Watkins, 2010). According to Lazarus (1993a) theories of coping as a process have been emphasized as two major functions of coping, problem-focused coping and emotion-focused coping. Problem-focused coping has the function of changing the troubled person-environment by acting on oneself or the environment. The function of emotion-focused coping is to change the relational meaning of what is happening (attenuating the stress although the actual relationship condition has not been changed) or changing the way the stressful relationship is expressed (Lazarus, 1993a).

It can be very powerful to change the relational meaning of what is happening when regulating stress and emotions. A comment by someone might for example be taken as demeaning. To avoid feelings of anger and potentially negative consequences, an excuse can be made to explain that the person leaving the comment for example is suffering from work stress, this is to bring forth empathy instead of anger so that anger does not have to be felt by the person receiving the comment (Lazarus, 1993a). Lazarus (1993b) argues that coping depends on if an appraisal indicates that there is something that can be done to change the situation. If the appraisal indicates that something can be done problem-focused coping is dominating whereas if the appraisal indicates that nothing can be done the emotion-focused coping is dominating.

5.2 Active/proactive vs. passive/reactive coping

When looking at different coping styles at the animal level, the terms active and passive coping have generally been used (Maier & Watkins, 2010). The active strategy according to Salvador and Costa (2009) is at the behavioral level characterized by the fight or flight response, at a physiological level by the high basal levels of the hormones testosterone and noradrenaline, and a high reactivity to the somatic nervous system which can be represented by the reactivity of the blood pressure and the plasma catecholamines. The passive strategy is in comparison to the active strategy characterized by a narrow social activity and at the physiological level known by a parasympathetic response, a reduced level of testosterone, and a greater response from the HPA axis (Salvador & Costa, 2009). Koolhaas et al. (1999) have summarized the physiological and neuroendocrine differences between active and passive animals, which has been adapted and can be found in table 2.
Stress – from a biological, social, and psychological perspective

<table>
<thead>
<tr>
<th></th>
<th>Active</th>
<th>Passive</th>
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<tr>
<td>HPA axis activity</td>
<td>Low</td>
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<tr>
<td>HPA axis reactivity</td>
<td>Low</td>
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<tr>
<td>Sympathetic reactivity</td>
<td>High</td>
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<tr>
<td>Parasympathetic reactivity</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Testosterone activity</td>
<td>High</td>
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Table 2. Differences in physiology and neuroendocrinology depending on an active or passive response to a stressor, adapted from Koolhaas et al. (1999).

Active coping strategies can be useful when the stress is escapable whereas passive coping strategies can be useful when the stress is inescapable (Bandler, Keay, Floyd, & Price, 2000). It has been defined that the midbrain PAG is a region containing distinct neural substrates, initiating passive or active emotional coping strategies. Excitation of the ventrolateral PAG (vlPAG) is triggering a passive coping response which can be characterized either by an arising pain or a severe hemorrhage. This suggests that spinal and nucleus of the solitary tract afferents might be carrying afferent signals arising from deep visceral or muscle tissue. The column of lateral PAG (lPAG) is mediating coping strategies characterized by engagement with the environment and receives topographically organized somatosensory afferents. Inputs like these travel through routes in the brain that for instance can affect skin pain or touch, which in turn could trigger different active coping strategies (Bandler et al., 2000).

The evolutionary process of the development of the cerebral cortex called encephalization results in a migration function from subcortical centers to the cortex (known as corticalization) of both emotional and higher associative functions. It could be argued that the greatest cortical expansion occurs within the orbital and medial PFC (OMPFC) and it is well established that damage within the OMPFC alters the capacity of higher mammals to cope emotionally with different situations sharply (Bandler et al., 2000).

Bandler et al. (2000) state that accompanying with the anatomy, studies using Fos-expression as a marker of neural activation revealed that a passive emotional coping reaction (usually triggered by physical stressors) evoked Fos-expression selectively within the vlPAG column (Bandler et al., 2000). Fos-expression can be described as C-fos, which is a proto-oncogene (which is a normal gene that can become an oncogene due to increased expression...
or mutation) and is expressed followed by a depolarization within some neurons (Bullitt, 1990). The c-fos protein can be identified by using a so-called immunohistochemical technique, which is a technique using microscopy to visualize cellular components e.g. proteins in tissue samples (The human protein atlas, 2017). After a peripheral stimulation, the c-fos expression can be used to show neuronal activity through the neuraxis (Bullitt, 1990). The word neuraxis is defined as the “axial and unpaired part of the CNS” by the Oxford dictionaries (“Neuraxis”, 2017).

Comparatively, Fos-expression was evoked within the IPAG and the vIPAG column following physical stressors which initially elicited an active coping reaction, followed by a period of passive coping. During active coping, consistent Fos-expression is not elicited by physical stressors triggering the active coping. This lack of Fos-expression within the dorsolateral PAG (dlPAG) is comparable to anatomical findings that the dlPAG does not receive a direct spinal or nucleus of the solitary tract input. It has been suggested that the dlPAG might be a component of a circuit triggering active emotional coping in response to psychological rather than physiological stress (Bandler et al., 2000).

5.3 Ways of coping questionnaire

The study of coping has been viewed as essential to get an understanding of how stress affects people by many of the researchers studying coping. Even though it has not been easy to understand or document, some researchers claim that the effects of unfavorable life-events can be reduced or amplified depending on how people deal with stress. These effects can affect not only emotional distresses and short-term functions but also the development of mental and physical health and disorder in the long-term (Skinner, Edge, Altman, & Sherwood, 2003).

The ways of coping questionnaire (WCQ) was developed by the Berkeley Stress and Coping Project in 1988. It is one of the most used techniques to calculate which kind of coping strategy a person has used during a stressful encounter. It is formed as an interview or a self-administered questionnaire and invites an individual to clarify the thoughts and actions he is using when coping with a stressful situation. The ways of coping questionnaire consists of eight factors: confronting coping, distancing, self-controlling, seeking social support, accepting responsibility, escape-avoidance, planful problem solving, and positive reappraisal (Lazarus, 1993a). Confrontative coping refers to when aggressive efforts are used to manage the situation which can be a bit risk-taking. Distancing means to pull oneself away cognitively
from the threat to decrease the importance of the situation. Self-controlling aims at taking control over oneself’s actions and feelings. Seeking social support refers to actively search for emotional, informational, or tangible support. Accepting responsibility means to realize the own participation in the problem and make an effort to solve it. Escape-avoidance is about wanting to avoid or escape the problem both at a mental and a physical level. Planful problem solving is when efforts are made to change the situation by analytically solve the problem. Positive reappraisal refers to when a person is trying to refocus the problem to a situation with a positive meaning, which in turn can open up for personal growth (Sandover, Jonas-Dwyer, & Marr, 2015).

The WCQ has been used in a variety of contexts to study coping strategies e.g. loneliness, psychological loss, personal failure, or chronic and acute illness. The coping area has been affected by the WCQ though the widespread use of the scale has led a number of research studies to focus on the set of basic coping dimensions assessed by the WCQ (Parker, Endler, & Bagby, 1993). The WCQ was designed as a process measure and not to assess coping styles or traits. It is still possible to look for consistency across various occasions by repeating the measure and then doing intraindividual analyses. Each time the measure is being done, the focus should be on coping processes in a specific and particularly stressful situation rather than traits or coping styles (Folkman et al., 1986).

Sandover et al. (2015) used the WCQ to investigate what kinds of methods students used to cope with problems in their everyday life. The results showed that graduate entry medical students favored coping strategies such as planful problem solving whereas undergraduate students seemed to prefer confrontive coping and accepting responsibility. The study also showed that males seemed to prefer coping strategies such as self-controlling whereas females seemed to favor planful problem solving and seeking social support.

5.4 The stress-coping model

The stress-coping model is a model of a cascade of responses starting with a stressor and is pictured in figure 4 (adapted from Olff et al., 2005). The first step in the model is the cognitive appraisal referring to how the stressor is perceived, interpreted and evaluated, and if the stressor is perceived as a threat or a challenge. After this appraisal phase, the emotional, behavioral, and physiological responses depend on the person and his specific coping and defense strategies. A defensive coping strategy will affect the appraisal of the stressor by turning the perception away by minimizing the negative affective response of the threatening
characteristics of the stressor. Defensive strategies are described by Olff et al. (2005) as an emotion-focused form of stress-coping and might in the short-term be beneficial but in situations where it is important to be realistic, the defensive strategies might be close to dangerous.

In this model coping consists of problem-focused strategies where the individual wants to experience control over the situation and therefore tries to actively attack the stressor (Olff et al., 2005). Problem-focused coping seeks to deal with the source of the stress and might therefore be more effective in the long term than the defensive strategies. Emotion-focused strategies include expressing emotions and seeking social support. The neuroendocrine stress response depends on if the stressor is appraised as threatening or challenging. The aim of the threat response pattern is to protect the individual from an attack while the challenge response pattern serves to increase energy for coping. How the stressor is appraised is then associated with different profiles of endocrine and sympathetic arousal (Olff et al., 2005).

After the appraisal phase, it is through the choice of coping strategies that the individual attempts to either change the stressful reality or regulate his emotional reactions. The experience is then associated with signs of recovery. These responses are decisive for mental and physical health outcome (Olff et al., 2005).
5.5 Coping and the brain

In a study by Holz et al. (2016) they tried to find out whether there is a link between coping styles, the ACC volume in the brain, and internalizing symptoms. Findings indicated that positive coping (stress-reducing) styles can be associated with increased ACC volume. Both anxiety and depression could be predicted by positive coping styles and ACC volume. Positive coping styles were classified as stress-reducing whereas negative coping styles were classified as stress-enhancing. Though the focus of the study primarily was on the positive coping styles it was divided into three dimensions:

1. devaluation/defense (telling oneself that everything will be ok)
2. distraction (trying to distract oneself)
3. control (tell oneself that he can cope with this)

A subregion of the ACC is called the perigenual ACC (pACC) and is a region linked with social processing and regulating negative emotions. This is by supporting a potential role in assigning resilience and risk to stress-related disorders such as anxiety and depression. Important to note is that the pACC is also closely connected to other cortical and limbic areas, including the hippocampus and the amygdala, which makes it unlikely to induce these complex neurobehavioral processes alone. An increase in ACC volume and positive coping styles were also associated with decreasing depression and anxiety in females. No such patterns were observed in males (Holz et al., 2016).

In a study by Collins, Mendelsohn, Cain, and Schiller (2014) 28 healthy adults were brain scanned with a technique called functional magnetic resonance imaging, which is used to detect changes in the cerebral blood flow. When using one area of the brain, there will also be an increase in the blood flow in that area and the brain activity can be measured. The participants performed a task as they were trained in active coping. Through trial and error the participators learned to avoid getting mild electrical shocks by moving a virtual marker between two game board sections over and over again. The brain-scanning showed that the mPFC, the caudate and the amygdala were somehow involved in causing an active coping behavior. By the end of the training, the synchronization between the amygdala, caudate and the mPFC subregions could be predictive if individuals would achieve a successful active coping performance (Collins et al., 2014).

Collins et al. (2014) consider it possible to manage threats through a neural circuit where the amygdala, the striatum, and the mPFC is required. If these components would fail
to function together there might be underlying symptoms of anxiety, which may impair the individual ability to actively cope with stress.

According to de Boer, Buwalda, and Koolhaas (2017) it is the individual differences in stress coping styles that plays an important role when it comes to fitness and health. They propose that the coping style should be sorted out into several behavioral areas, for example emotional reactivity, flexibility or impulse control, and harm avoidance or reward processing. Each of these areas connects to selective neural circuitries. The flexibility or impulse control which is part of the executive control behavior seems to be closely linked with the PFC and the PFC functions. An evolutionary ancient neurotransmitter system of serotonin (which is also known as 5-Hydroxytryptamine = 5-HT and can be found in the CNS) sends a close innervation to the PFC (de Boer et al., 2017). 5-HT has also been found to be involved in the regulation of aggression throughout the animal kingdom (Kravitz & Huber, 2003; Miczek et al., 2004).

Walker, Masters, Dielenberg, and Day (2009) argues for the choice of when and how to assess coping behavior, as a critical factor. It has been found that when assessing coping during a conflict the “active” invader is affecting differences in the activation of the forebrain structures which in turn regulates the HPA axis response to the stressor. When experiencing social defeat the active invader also evoked smaller rises in plasma glucocorticoid responses.

In summary: Coping strategies can vary in their efficiency. For instance, thinking positively about a situation seems to be quite effective but depends essentially on personality, whereas seeking social support can be more ineffective and depends on the social context (Lazarus, 1993b). How useful a coping pattern is varies with the type of stressful encounter and the subjective well-being, the somatic health, or the social functioning. A specific strategy might not work all the time and in every situation, different strategies might therefore be useful in different situations. When the individual himself cannot affect a situation (for example while waiting for a grade to get announced) using the strategy of distancing can be helpful to reduce the distress. In another situation, when for example an exam is upcoming, distancing oneself might not have the same effect since this strategy might lead to an abandoning of the effort to prepare for the exam. The distress might be reduced by distancing oneself but the chances of passing the exam might be reduced too (Folkman & Lazarus, 1985).

An effective coping strategy seems to be related to areas of the brain like the ACC, the mPFC, the hippocampus and the amygdala. According to Holz et al. (2016) positive coping
styles reduced both anxiety and depression as there was an increase in ACC volume, even though this was only found in women.

6. Discussion

The aim of the paper was to give a brief overview of the concept of stress. The focus was to describe stress from a biological perspective and to describe what happens in the brain and the body during stress. The focus was also to describe stress from a social and a psychological perspective and to describe how stress is affecting the mind. The last part focused on the concept of coping and how dealing with stress can affect the brain, the mind, and the body. The discussion will contain a brief summary of the most important findings in this thesis in relation to:

- how biological, psychological, and social factors affect perceived stress
- a comparison of the different coping strategies in relation to stress and their efficacy

The stress response aims at helping humans survive challenges and threats, it helps to perform and is therefore a response that we need to be able to survive. The main problem with the stress response is when it becomes chronic and is activated even when there is nothing threatening us. The stress response has been shown not only to affect the body but also to affect the brain. In relation to stress, involved areas of the brain seem to be mostly related to the PFC, the ACC and the OFC. Being exposed to stress over a long period of time can cause damage in the amygdala and in the hippocampus which can result in lesions related to fear, learning, and memory.

Most research about stress is linked to the activation of the HPA axis and it seems that it is the over-activation of the HPA axis that is especially threatening to the human body. When the body no longer can regulate the activation of and reset the HPA axis to its baseline, the fight-or-flight response is constantly active even when there are no existing threats. The SNS dominates over the parasympathetic nervous system and makes, for example, the heart beat faster whereas the parasympathetic nervous system tries to slow down the physiological response to be able to relax. The HPA axis is releasing a hormone called cortisol which is important for many of the physiological functions in the body, e.g. increasing the blood glucose level, suppressing the immune function and breaking down body tissue. If the perceived stress is not removed, the effects of stress hormones (cortisol) tend to accumulate (Juster et al., 2010).
The over-activation of the HPA axis has been found to depend on individual differences, what kinds of differences is not always clear. Meaney (2001) states that these individual differences, responsible for regulating behavioral and endocrine responses to stress, occur due to naturally occurring variations in maternal care. It is the mothers behavior toward her offspring that in a way programs the behavioral and neuroendocrine responses to stress when the offspring becomes an adult (Meaney, 2001).

**Biological, social, and psychological aspects of stress**

Research on the term stress can be traced back to the 14th century. Thus, the concept has a long history and has been discussed by several researchers over the years. Engel (1977) raised the question, whether it wasn't time for a wider medical view than to just look for the biomedical mechanisms when treating diseases. Since then a debate has progressed concerning the question whether a BPS model is the answer to this question or not.

Borrell-Carrió et al. (2004) argue in the dualistic tradition that stress involves both mind and body. The researchers agree that the BPS model has been helpful in expanding how health and illness are viewed during the years, but also indicates problems with the model. One thing they point out is that categories such as mind and body are created by us - humans. It lies in our nature to understand our surroundings and to make that easier we tend to for example separate concepts from each other into different categories so that we easier can understand the concept. When categories are taken too literally it can prevent us from thinking outside the box due to boundaries that we have ourselves have come up with and that in fact do not really exist.

Biological aspects of stress refer to the stress response in the body where the CNS sending signals to the body via the brain and the SNS which in turn for example makes the heart accelerates and gets the body ready for action, known as the fight-or-flight response (Gazzaniga et al., 2009). The brain is active in detecting threats and is an important organ for sending behavioral and physiological responses (McEwen, 2007). Areas in the brain such as the PFC, the ACC, and the OFC are important for regulating the stress response and maintaining health (McEwen & Gianaros, 2010). The HPA axis and the SAM axis are responsible for activation of chronic and acute responses to stress, this is to activate areas in the body and the brain to physically defend the stressor (Bitsika et al., 2014).

Psychological and social stress is described as being affected by how a threat or a situation is appraised by the individual (Gianaros & Wager, 2015). Social stress seems to be
related to the social environment around the individual, which can cause stress if the individual believe that he is on his own (Aneshensel, 1992). The stress might then be handled by seeking social support and building social bonds (Eisenberger & Cole, 2012).

Psychological stress seems to be affected by the locus of control, self-efficacy, and cognitive appraisal. According to Bandura (1991) self-efficacy is the belief that the individual can handle a stressful threat or situation on his own. With a high self-efficacy, the individual sees success forward whereas an individual with a low self-efficacy sees failure forward which can cause the stress to mount. Ajzen (2002) describes the locus of control as being affected by willpower and skills. If the outcome of a situation depends on individual actions and skills rather than luck, the individual will take more credit for managing the situation.

Cognitive appraisal aims at how feelings and thoughts are appraised in relation to a stressor. How the stressor is appraised affects actions and behaviors to cope with the stressor (Lazarus, 1993b). Cohen and Wills (1985) state that the concept of cognitive appraisal can be seen as a subjective concept though it depends on the individuals own view of what is classified as a stressful situation.

Because the concept of stress has been used for many years and in various researches the term stress can be used with different meanings. Looking at stress from various perspectives can give a greater understanding of the relationship showing when a perspective work well whereas another perspective does not work well. Someone may for example have a good health and a healthy body but at the same time troubles with finding good and loyal friends, which might lead to that the individual are biologically fit but not psychologically feeling fine.

The phenomenon of stress is as relevant today as it was when Robert Hooke used the concept in the 17th century. According to Gazzaniga et al. (2013) the interaction between biological, psychological, and social factors need to be considered when looking at someones health. All these aspects need to be considered to maintain a good mental and physical health.

**Coping strategies and their efficacy**

Bandura (1991) developed the concept of self-efficacy which is about the individual belief that one can manage a specific situation. Self-efficacy and self-esteem are two separate concepts but both of them refer to the belief of how one will act in a given situation or action and how well one will act. Schwarzer and Renner (2000) state that self-efficacy has been found to be crucial in general lifestyle changes, for example changes connected to physical
exercise and social support. People with greater self-efficacy also seem to be better at making a change in their lives and to stick to their new plan.

How someone decides to handle and cope with a situation can be seen in different strategies. What kind of coping strategies an individual decides to use in different situations can, therefore, be reflected in the individual self-efficacy. When being exposed to a stressor an individuals beliefs that he can handle the stressor depends on his self-efficacy. The self-efficacy depend on which coping strategy is chosen and how the coping strategy is performed. Both the choice and the execution of the coping strategy is then affected by the individual self-efficacy.

Scherer (1982) indicates that when connecting control with emotions, a subjective feeling occurs and the organism quickly must evaluate its ability to cope with a situation, but this is much more complicated due to the controllability. Sometimes we are unable to control a situation, for example no-one can control an earthquake. Another example when we are unable to control a situation is when someone else is in control of the situation. When doing research on emotional responses, Weiner, Russell, and Lerman (1979) found that different emotional responses were associated with both failure and success depending on if the cause of the outcome was attributed by oneself, by others, to others, or by chance.

Lazarus (1993a) pointed out that coping can be divided into two subgroups named emotion-focused and problem-focused coping. Emotion-focused coping aims at regulating the emotions related to the stressor whereas problem-focused coping aims at taking care of the stressor. In a situation that Scherer (1982) describes as out of control for the individual, it would be hard to use problem-focused coping and therefore a better alternative would be to use emotion-focused coping, whereas if a situation can be handled by the individual, problem-focused coping can be favorable. Even if the situation can be handled, emotion-focused coping can in some situations be the best coping strategy to use.

Several factors affect how advantageous a strategy is to use in a specific situation, for example the situation itself and the background to why it occurs. Individual differences and personality might also affect the reaction of an individual and how he defends himself. Surroundings, mood, and surrounding people can affect which strategy is chosen. To get a better understanding of when and why some coping strategies seem to work better than other coping strategies, future research needs to review specific strategies in specific situations and be analyzed to answer questions like these.
Limitations, gaps, and future research

The stress-coping model used in this thesis is a model describing the link between coping and how it affects different levels such as a stressor, mental health, and physical health. Now it has past over 10 years since the model was presented for the first time and one thing to keep in mind is that the model is not that widely used today. This can depend on several factors, for example the research on coping is in general not that broad. The model is included in this thesis because it is not a one-way model, each of the levels from the stressor to mental and/or physical health can be affected by the higher levels of for example coping and social support. Since stress can influence people in different ways the stress-coping model makes it possible to include some of the differences.

Cognitive appraisal aims at someones perception of a stressor. If it is perceived as a threat or a challenge it can affect the individual response to the stressor. In the stress-coping model, the appraisal is its own category that according to Olff et al. (2005) is decisive for the out-coming behavioral/emotional response or the neuroendocrine response. This is strengthening the view that how someone appraises a stressor can be an important aspect of how the stressor is later handled and how the health is affected. It would be interesting if future studies would look deeper at the individual differences related to perception to see if the differences for example depend on evolutionary aspects, childhood, or related psychology.

The focus of this thesis has partly been to describe the social aspects of stress and coping. Personality has not been discussed in this thesis though it is closely linked to the field of social psychology which was not the aim of this study to examine. For future research, it would be interesting to look for personalities and individual differences that can be related to stress, especially looking at social and psychological aspects. This would require a detailed analysis of personality types and a mapping of numerous peoples personalities. After this extensive phase, the testing of different stressors and coping strategies can be followed.

It would be interesting to compare biological stress with social and psychological stress to see if there are similar effects in the long-term being exposed to different kinds of stress. It would also be interesting to simultaneously look for biological, social, and psychological effects of stress in order to distinguish how these effects of stress differ.

In this thesis there have been findings indicating that the ACC, the hippocampus, the amygdala, and the PFC play critical roles when it comes to responding to stress. There have also been findings that positive coping strategies can increase the activation in at least these
areas. This increase has been linked to a decrease in anxiety and depression. For future studies, these areas would be interesting to investigate further with questions like for example: what exactly is the individual doing when this area is increasing, what is the difference between genders (if there is any), is the individual familiar with for example positive coping, is there a difference if the individual has exercised positive coping earlier, or how long does the increase of these areas stay?

Stress is a term that has been used for many years and is by many people related to a personal subjective feeling. One of the hardest things when studying coping and perceived stress is that it is mainly dependent on self-reflecting scales or interviews that have been done, for example after the coping has occurred. It seems that it has been hard to trace the exact moment when stress occurs and what happens, especially in the brain. In the future it would be interesting if studies of stress to a greater extent would make use of e.g. magnetic resonance imaging to look for changes and development in the brain. This would then lead to a greater understanding of what is happening in the brain during and after stress, and how it could differ between subjects.

7. Conclusion

The main task for the stress response is to help humans manage a challenge, survive a threat, and to perform at a maximum level in a stressful situation. The CNS, the brain, and the HPA axis are biological aspects that work together, both to activate and to shut down the stress response. If the stress response is chronically activated (even when the subject is not being exposed to a threat) it can lead to damage in for example the amygdala and the hippocampus, which in turn can lead to diseases and impairment such as cardiac disease, memory loss, or lesions related to fear and learning. The social and the psychological aspects of stress relate to the mental aspects of stress, like how a stressor is appraised and if it can be controlled, this can in turn be an important factor to why the level of stress is perceived different by various people. Coping is a concept about how someone handles a stressful situation both mentally and physically. The most used coping strategies seem to be either problem-focused coping or emotion-focused coping, aiming to deal with either the stressor or the relational meaning caused by the stressor. In this thesis the BPS model of stress was described to illustrate how biological, psychological, and social factors all affect the health both in a mental and a physical way. The BPS model of stress has been helpful in broadening how health and illness has been viewed over the years by including the involvement of both the mind and the body in relation to stress.
References


