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I. Introduction

This study proposes to explore the nature of social isolation and loneliness in humans through a multi-level and multi-methodological approach. This is accomplished by using the already well-researched field of hunger and fasting as a comparative model in order to highlight the distinct physiological and psychological responses caused by a period of social isolation and the perception of loneliness.

The term *deprivation* offers a link between the two and thus, an opportunity to learn more about responses to isolation. Deprivation of food leads to the feeling of hunger, which is caused and accompanied by a complex cascade of (neuro-) biological, psychological, and cognitive reactions in the body, all of which have been thoroughly researched, but not yet completely understood (Herbert et al., 2011; Huh et al., 2015; McKinley et al., 2019; Chen et al., 2016; Rohleder & Kirschbaum, 2007).

However, when we consider social connection as a crucial innate need in itself and not just a mean to fulfill non-social needs, we must consider that social isolation causes a similar cascade of mechanisms to ensure survival (LeDoux, 2012; Cacioppo et al., 2011; Matthews & Tye, 2019; Tomova et al., 2019). In that sense, the process of responding to the discomfort of the aversive motivational state that comes with social disconnection is called *social homeostasis* (Matthews & Tye, 2019). This study attempts to uncover responses to social deprivation, and uses research on hunger and fasting as a frame of comparison to best understand how our innate social needs manifest physiologically and psychologically.

The Paradoxical Disconnection of the 21st Century

During the late 20th and early 21st centuries, the proliferation of “personal technologies”, in combination with expanding globalism, led to drastic changes in our social lives. Young age groups no longer live in generational households or big communities, but in private, mostly rented-out apartment buildings, often times far away from family and friends. Although the development in personal technology has made it possible for people to connect with each other at all times and all locations, a paradoxical explosion of *social isolation* occurred (Matthews & Tye, 2019).

In 2019, the World Health Organization (WHO) declared loneliness a major threat to physical and mental health (Bzdok & Dunbar, 2020). Evidently, the modern lifestyle and the consequences of individualism have caused chronic states of *loneliness* (Cacioppo & Cacioppo, 2018). Studies have shown that loneliness in industrialized countries, independent

from factors like socioeconomic status, gender, and ethnicity, range from 25-50% for people who feel lonely at least some of the time, and 5-10% who feel lonely frequently or very often—and these numbers are growing (Cacioppo & Cacioppo, 2018). Loneliness and its observed consequences, such as higher mortality rates and mental illnesses such as depression and anxiety disorders, became an even more pressing issue in the midst of the global Covid-19 pandemic (Bzdok & Dunbar, 2020). Physical distancing became an act of solidarity and caused an increase of isolation especially for our most vulnerable members of society. Enhancements in the health care system and in disease detection capacities led to growing life expectancies in most countries of the Western Hemisphere (Cacioppo et al., 2015), which led to a demographic shift towards an aging society. We can confidently state that the elderly are more socially isolated than ever before (Cacioppo & Cacioppo, 2018).

Although most research about loneliness has focused on older generations, it is important to note that younger age groups also face consequences of a highly individualistic oriented society (Holt-Lunstad et al., 2015; Matthews & Tye, 2019). The emergence of social media, cyber relationships, and cyberbullying in industrialized nations also led to an increase of perceived loneliness and its side effects in younger age groups (Cacioppo & Cacioppo, 2018). Social isolation can be found in multiple different forms like rejection, exclusion, discrimination, or loss, and it comes along with mostly negative emotional states (Matthews & Tye, 2019). Loneliness is a multifaceted and multilayered phenomenon that affects the elderly as well as the young, albeit in different ways, and independent from socioeconomic, cultural, or ethnic backgrounds (Holt-Lundstad et al., 2015). Understanding the underlying mechanisms behind the need for social connection is therefore crucial for developing further clinical implications as well as extending preventive measures for those affected by loneliness and social isolation.

For the purpose of this study, we must distinguish between objective isolation and loneliness. While loneliness is a subjective feeling, social isolation describes the objective physical state when one is out of physical reach of other people (Cacioppo et al., 2011). Being socially isolated does not necessarily mean that you are feeling lonely, but is a risk factor, and can be interpreted as an alarm signal for your system because you are more likely to feel lonely when you are physically alone (Hawkey et al., 2015). On the other hand, you can feel lonely while being surrounded by other people, and in this sense, loneliness describes an internal state that is not satisfied.

Research showed that even the perception of loneliness is enough to negatively affect longevity, mental health, and physical health (Matthews & Tye, 2019). Both loneliness and social isolation are associated with poor health behaviors like smoking, physical inactivity, and poor sleep quality (Cacioppo & Cacioppo, 2018; Holt-Lunstad et al., 2015). This link to poor health behaviors makes it difficult to differentiate between the immediate short-term effects on our health due to physiological responses and the long-term effects caused by detrimental psychological effects.

Although loneliness is referred to as its own uprising pandemic, it is often difficult to evaluate and measure it, due to various factors. One important factor is that loneliness is a subjective feeling and therefore difficult to study objectively, as well as to mimic in a laboratory setting. Psychological research on emotions in humans mostly relies on self-report questionnaires, what makes it prone to blind spots due to social desirability (LeDoux, 2012). Talking about loneliness and mental health is often associated with shame and stigma, which makes it difficult to evaluate how many people are willing to openly admit that they feel lonely or disconnected (Bzdok & Dunbar, 2020).

When we consider human beings as a social species, it is not surprising that the feeling of loneliness has the power to impair our lives heavily. Organizations and networks have always been crucial for survival and support, which makes it logical to assume from an evolutionary point of view that our bodies and brains developed very specific responses to the threatening state of social isolation (Cacioppo & Cacioppo, 2018). Hormonal, cellular, behavioral, and genetic mechanisms shape the way we interact with others to ensure reproduction and genetic legacy. Therefore, taking social interaction away must highlight its effects on these underlying mechanisms (Hawkley et al., 2015). Although we know a considerable amount about the long-term consequences of loneliness by now, we do not yet understand the underlying mechanisms and short-term effects of social isolation, and how they are incorporated in our basic survival system (Matthews & Tye, 2019). In order to understand the effects of social isolation best, we must first understand what a social survival circuit might look like and how different biological responses might interact with each other. Therefore, I will provide an overview of the mechanisms involved in homeostatic processes, and the stress response, as well as hypotheses about the nature of emotional reactions in states of deprivation—both in regard to food and social deprivation, and their consequences.

II. Theoretical Background

In the following section I will describe the theoretical components about the effects of fasting and social isolation on our bodies—both biologically and emotionally. This gives us a basic understanding of how and why our bodies and minds respond to aversive and life-threatening states the way they do. Because the state of hunger represents a well-researched field about the nature of deprivation, it is used as a framework to complement our knowledge about social isolation, and offers a comparative structure of an aversive state, which possibly triggers parallel reactions on our motivational drives, our stress response, and the affective echo.

Homeostasis

To ensure survival, our body developed coordinated systems of adaptive behaviors towards specific stimuli in our environment in order to protect life-sustaining functions. In opposition to our lack of knowledge about the basic survival mechanisms involved in our social needs, we know a lot about other basic survival circuits that regulate our system in terms of nutritional supplies, thermoregulation, reproduction, fluid balance, and defense mechanisms (LeDoux, 2012; Matthews & Tye, 2019). These survival circuits assure that our body can maintain a healthy balance through the dynamic process of *homeostasis*, which describes the physiological processes and maintenance of an organism's internal environment despite external changes (Bear et al., 2016). For example, homeostasis regulates our body temperature, pH levels, and maintains balanced concentrations of bodily fluids, such as the glucose level in our blood. Homeostasis can be described as a general phenomenon that regulates the ongoing physical variables in our body.

While homeostasis describes the maintenance of a stable internal environment undeterred by external factors, *allostasis* describes the adaptive process of achieving stability through behavioral and physiological changes, and in specific, when stressful and sudden changes occur (Ramsay & Woods, 2014). Allostasis provides compensation within the internal viability so the body can adapt quickly in predictable as well as unpredictable circumstances. This is achieved among other processes by changes in the *hypothalamic-pituitary-adrenal-activity* (HPA-activity) and alterations in the *autonomous nervous system* (ANS) through an internal feedback system (Schulkin, 2011).

In nature, allostasis creates beneficial effects for our physical wellbeing through compensational mechanisms. However, modern lifestyle and societal issues, such as war,

violence, and poverty cause chronic stress and compromise these compensation mechanisms (Ramsay & Woods, 2014). Through continuous exposure to stressful events that demand allostatic responses, an allostatic overload can occur and result in “wear and tear” manifestations (Schulkin, 2011). This also explains why the elderly tend to suffer more severely from internal and external imbalances. A disruption of the homeostatic system occurs and creates overexertion of the physiological allostatic system. Modern lifestyle also causes states of chronic stress and therefore dysregulates the mediators of allostasis, i.e., through constant overeating or sleep deprivation (Schulkin, 2011). This lack of equilibrium can be chemically measured by examining the central nervous system, the ANS, and the endocrine system.

To better understand the cascade of mechanism caused by homeostatic imbalance we must take a closer look at nutritional regulation. We become aware of the state of hunger by signals of energy deficiencies such as a decrease of glucose levels and an increase of orexigenic signals, for instance the hormone ghrelin (Bear et al., 2016). Food seeking and consumption are therefore regulated by neurons that monitor metabolic signals (Atasoy et al., 2012). Physiology and behavior are both regulated by this process. As soon as the deprived need is met, these motivational behaviors are inhibited by the homeostatic system through the feeling of satiety (Bear et al., 2016). However, disruptions of this adjustment system can occur among other states of long-term deprivation or constant overeating, and therefore lead to health implications such as eating disorders and/or addictive behaviors (Ferrario et al., 2016).

Just like homeostatic signals can be overridden and altered through imbalanced nutritional supplies, we can see shocking consequences of social disconnection and loneliness not only in humans, but throughout the animal kingdom and across a lifespan (Loseth et al., 2014; Matthews & Tye, 2019). Matthews and Tye (2019) stated that when considering social connection as an innate need, we can assume that we do have underlying neural systems keeping that state of social homeostasis, which means that we are alerted by the lack of contact to seek social connection. Disruption of neuroendocrine and autonomous functioning, as well as negative behavioral and emotional changes through social isolation, were found in several animal studies (McNeal et al., 2014; Matthews & Tye, 2019; Grippo et al., 2007; Bosch et al., 1996). A rodent study was conducted by Matthews and Tye (2019) to better understand how loneliness preserves long-term disease states that most likely result from sustained recruitment of social homeostatic circuits.

Matthews and Tye (2019) introduced the idea that coordinated adaptations across neural circuits function to maintain social homeostasis, just as they maintain nutritional homeostasis. They encouraged a mechanistic understanding of how deficiencies in social connection can be identified and evaluated. Being socially isolated can trigger a survival threatening state, which might not have an immediate impact on internal physiological stability, but an evolutionary conserved neurophysiological mechanism that causes underlying short-term adaptations (Cacioppo et al., 2014). In that sense, researchers are searching for the source of biological (im)balance that triggers the cascade of regulative processes in terms of social needs, just like the mechanisms signaling changes in the glucose levels caused by food deprivation. For that purpose, animal studies were conducted to observe physiological changes in forced phases of social isolation (McNeal et al., 2014; Matthews & Tye, 2019). For example, a study by McNeal et al. (2014) showed the impact of disrupted social bonds on the cardiovascular health and behavioral responses of prairie voles.

Matthews and Tye (2019) used research on rodents to further deepen their understanding about the concept of social homeostasis. They found that when prairie voles are separated from their social environment for a short amount of time, they develop signs of distress and showed heightened levels of cortisol. They also increased social contact seeking behavior, which can be interpreted as the motivation to leave an aversive state and search for relief of the suboptimal state. To explain those results, Matthews and Tye (2019) illustrated that the neural response to social deficit must imply a monitoring of the social condition—a detective system for a homeostatic set point in the control center and the activation of an effector system to elicit an appropriate response. That means that a deficit in social connection, either actual or perceived, would activate that system, and therefore leads us to conclude that loneliness represents an aversive state that heightens vulnerability and motivates social reconnection (Tomova et al., 2019). However, the precise organization of the social homeostatic system remains unresolved (Matthews & Tye, 2019).

Stress

Humans and other mammals inherit two major systems that respond to stressful situations such as a state of nutritional or social deprivation: the HPA-axis, and the ANS. When the HPA-axis is activated, a complex set of interactions in the hypothalamus, the pituitary gland, and the adrenal gland begins that ultimately results in the release of the hormone cortisol (Bear et al., 2016; Wadsworth et al., 2019).

The hypothalamus releases corticotropin, which then releases the *corticotropin-releasing-hormone* (CRH) into the blood circulation and triggers a release of *adrenocorticotropin-hormone* (ACTH). In response to an elevation of the blood level of ACTH, the hormone *cortisol* is released from the adrenal cortex (Bear et al., 2016).

Nutritional supplies maintain the energy balance in our body and are crucial for our survival. Therefore, fasting signals a state of deprivation and is followed by the motivation to seek food (Herbert et al., 2012). However, results regarding the effect of fasting or nutritional deprivation on the HPA-activity and the overall stress response are not conclusive (Rohleder & Kirschbaum, 2007; Gonzales-Bono et al., 2001; Bear et al., 2016; Atasoy et al., 2012). Although orexigenic signals, such as the release of *ghrelin*, seem to have a stimulating effect on the HPA-axis activity (Rohleder & Kirschbaum, 2007), empirical data showed that fasting subjects who are put into a stressful situation had a suppressed activation of the HPA-axis (Rohleder & Kirschbaum, 2007; Gonzalez-Bono et al., 2001). Other studies point to a dynamic interaction between cortisol, ghrelin, and the perceived level of stress (Sarker et al., 2013). Therefore, the interaction of stress and food consumption is diverse: some people tend to compensate stressful situations with palatable food (Herman & Poligy, 1980), while others decrease their food intake during stressful times (Adam & Epel, 2007). These altered forms of food seeking and consumption can result in long-term health implications, such as organ damages, eating disorders, and addiction (Pool, Delplanque, et al., 2015). The underlying mechanisms are not yet fully understood, but the broad body of studies we have so far give us an idea about the physical response to food deprivation (Chen et al., 2016).

Similarly to the long-term effects of nutritional disparities, chronic loneliness causes not only higher rates of morbidity and mortality, but is also associated with high rates of depression and anxiety (Holt-Lunstad et al., 2015). These affective disorders and health implications can also be seen as stress-related properties (Doane & Adam, 2010). Decreased inflammatory control, immunity, and sleep salubrity are consequences of an increase in HPA-activity and a heightened sympathetic tonus. These consequences lead to higher rates of morbidity and mortality in older adults (Cacioppo et al., 2011). Stressful events are diverse and our bodies react to them through a coordinated response to threatening stimuli. Increased vigilance and arousal, avoidance behavior, the activation of the ANS, and the release of cortisol from the adrenal glands are the consequences of a neurobiological response starting in the amygdala and the hypothalamus (Bear et al., 2016).

When considering a state of deprivation as a stressful event we must consider that loneliness shows an effect on physiological stress responses in a similar way to hunger. Loneliness is considered as a stressor according to the *self-preservation hypothesis* (Cacioppo & Cacioppo, 2018). There is evidence that loneliness is associated with changes in HPA-activation due to the state of chronic stress, but this has been associated with higher amounts of cortisol in some studies and lower in others (McNeal et al., 2014; Grant et al., 2009; Kudielka et al., 2008; Nater et al., 2005). Researchers have proposed mixed study results regarding the effect of cortisol levels due to social isolation (Cacioppo & Cacioppo, 2018; Grant et al., 2009). There are different theories on how the different aspects of loneliness may display different temporal aspects: short intervals of loneliness may cause changes in the cortisol levels during specific times of the day, whereas chronic loneliness may have an overall effect on the HPA-activity, as we see in alterations in the *Cortisol Awakening Response* (CAR), in which cortisol levels increase about 50% 30 minutes after awakening (Cacioppo & Cacioppo, 2018). The CAR was shown to be more pronounced in relation to feelings of loneliness in a comparable way to general chronic stress (Strahler et al., 2017; Cacioppo & Cacioppo, 2018).

Chronic stress, independent of its source, impacts how we interact with the world and leads to alterations of our stress response system that consequently have detrimental effects on our physical well-being and mental health. Although research findings have been contradictory on how exactly short-term stressors like hunger or isolation interact with HPA-activity and the ANS, it is certain that further investigation is crucial for our understanding of the physiological and psychological effects (Cacioppo & Cacioppo, 2018; Holt-Lundstad et al., 2015; Nater et al., 2005).

Emotion

As explained earlier, alterations of our stress response system due to imbalances in our homeostatic system can damage our well-being and cause affective disorders, such as depression (Cacioppo & Cacioppo, 2018). When considering these long-term changes of emotional coloring, it is important to understand the short-term effects that deprivation states have on our emotions. Intuitively, everyone seems to know what *emotions* are, but when it comes to scientific research, a clear definition of emotion is still missing—therefore, measuring emotions is difficult and hardly objective. Outward expression is highly variable, and we rely on subjective questionnaires and self-report ratings, which makes it difficult to

produce a consistent body of literature on the subject (LeDoux, 2012). For the sake of consistency, I will refer to Ekman's canonical list of basic emotions, in which he stated that we have five to seven basic emotions (LeDoux, 2012): fear, anger, happiness, sadness, disgust, and surprise. To narrow it down I will focus on the sensation of anger in the following.

When speaking colloquially, people tend to get angry when hungry. There is evidence that the negative emotional affect while hungry, commonly referred to as "hangry", is more than just a myth, and that hunger in general is accompanied by heightened impulsiveness, aggression, and negative emotion (Hermanns et al., 2002; Gailliot et al., 2007). The root cause of mood swings due to hunger are not yet resolved, but there are multiple theories that highlight different physiological and psychological aspects of it. One hypothesis involves the neurotransmitter *serotonin*, which is also closely connected to affective disorders such as depression, and offers a link between food and mood (Bear et al., 2016). The *serotonin deficiency theory* suggests that low levels of the neurotransmitter cause negative mood states. Serotonin levels rise in anticipation of food and peak during a meal, and stressful periods have shown to be connected to higher levels of serotonin through carbohydrate intake (Bear et al., 2016). Alternatively, the *regulatory depletion theory* states that the increased level of anger during the state of food deprivation might result from the decreased activity in higher cognitive control systems, due to declining glucose supplies in the brain (Hermanns et al., 2002). Hermanns et al. (2002) has shown that the sympathetic activity of the ANS could be increased through an induced drop of glucose level in the blood, which is then accompanied by heightened self-reported arousal and negative affect.

Another potential explanation for the change in affect caused by a state of deprivation is offered by the *psychological constructionist theory*, which states that the negative mood is caused by a shift in resources for allostasis—meaning that our body is trying to keep the homeostatic balance within our system (MacCormack & Lindquist, 2019). The psychological constructionist theory also states that people experience change in emotion while experiencing bodily changes, which is also dependent on the context the person is in, and is not bound to one specific emotion (e.g. anger). Therefore, the power of context becomes highly relevant (MacCormack & Lindquist, 2019). Negative feelings might be intensified when homeostasis is threatened by numerous causes at the same time, e.g. glucose deficiency and social threat (MacCormack & Lindquist, 2019). The psychological constructionist theory

therefore offers an explanation that covers all states of deprivation and can be used in terms of food deprivation and social deprivation.

Just like the psychological constructionist view highlights the importance of context, the *misattribution theory of arousal* also states that humans misinterpret their arousal and incorrectly connect it to another stimuli, therefore misleading their emotional response (MacCormack & Lindquist, 2019). This theory is therefore not tied to a specific physiological response that is accompanied by hunger, but can also be used to explain why any aversive state in a specific context e.g., social isolation, could lead to an inaccurate emotional reaction. Although theories of physiological construction and affect misattribution fail to explain the complete root cause of mood shifts while hungry, MacCormack and Lindquist (2019) hypothesized that people experience hunger as “emotional” when they conceptualize their affective state as negative because hunger is an individual and subjective state depending on many physical factors such as diet, experience with fasting, and exercise. MacCormack and Lindquist (2019) conducted a study, in which a fasting period of six hours led to an increase in self-reported negative mood and high arousal emotions. They found evidence across their three study designs that hunger alters affective experiences and perceptions, concluding that hunger can become a meaningful state of “hanger” when put into a specific context. The misattribution theory states that this effect could only occur when the participants were not explicitly concentrated on their emotions. Therefore, it can be stated that hunger alone cannot cause negative affect, but the context of the situation or unconscious priming can.

I already described some of the detrimental effects chronic loneliness can cause to our physical health due to stress related properties. However, loneliness also leads to higher rates of negative mood, such as anger and aggression, and increased rates of anxiety (Cacioppo & Cacioppo, 2018; Cacioppo et al., 2015). The source of this emotional outcomes contains important questions about the basic biological mechanisms involved in the nature of feelings and emotions. Longitudinal research has shown that depressive symptomology and poor mental health are correlated with loneliness (Cacioppo & Cacioppo, 2018). Considering these long-term effects of loneliness, the question arises if there are negative short-term effects on the emotional state after a period of social disconnection, similar to those already observed in the state of food deprivation (MacCormack & Lindquist, 2019). While considering our need for self-regulation, and the evidence that showed lonely individuals perform poorer emotional regulation (LeDoux, 2012), the question arises if self-regulation is only “motivated” by

another person, or if social contact activates a crucial biological mechanism that allows us to execute self-regulation.

A psychological explanation is offered by the *social control hypothesis*, which states that internalized liabilities and influences of network members tend to encourage beneficial health behaviors, such as exercising and a healthy diet, and discourage poor health behaviors, such as smoking and alcohol consumption (Cacioppo & Cacioppo, 2018). One example is the influence of marital partners on the overall likelihood of engagement in beneficial health behaviors. Being married is associated with an increase of regular and continuous exercise (Cacioppo et al., 2011). However, the consequences of social isolation cannot be explained by the social control hypothesis itself. It insufficiently explains the partly paradoxical effects that social isolation causes in humans and it offers no explanation for the immediate detrimental physiological effects of isolation we already observed in non-human social species studies (McNeal et al., 2014).

Theories about affective responses in states of deprivation contain biological explanations such as lower energetic resources due to homeostatic processes and the serotonin release, as well as psychological explanations such as the misattribution of arousal in a specific context. One theory will probably never be able to fully uncover every aspect of changes in emotions, but the sum of possible interpretations and theories can be seen as useful tools to reveal the complex response deprivation provokes.

Human Studies

In response to what we know so far from animal studies (Matthews & Tye, 2019; McNeal et al., 2014; Cross et al., 2004), namely that periods of social isolation cause striking changes in brain functions and disrupt behavior, Tomova et al. (2020) conducted a study on the effect of social isolation on the desire for social contact, and compared it to the craving we feel when hungry. The study was based on the evolutionary perspective of loneliness introduced by Cacioppo and Cacioppo (2018). In thinking in evolutionary terms of loneliness as an adaptive signal similar to hunger and thirst, it must be accompanied by the motivation to change the social behavior in order to have higher chances of survival.

Because research on the underlying neurobiological mechanisms and neural representations of unmet social needs has been limited so far, Tomova et al. (2019) used fMRI-scans to look at the differences in neurological response, and found out that acute

isolation causes social craving similar to the craving for food after a period of fasting. In response to social cues, human brains evoke a “social craving” for connection, which means that social interactions are meaningful in themselves and not merely there to fulfill non-social needs. The results showed that social craving was more variable across participants than food craving. The assumption is that the variety is caused by diverse pre-existing levels of loneliness. Participants who showed higher rates of loneliness before, showed less desire for social cues after the session.

Aim of this Study

The goal of this study was to explore the nature of short-term consequences of social isolation on the level of physiological stress responses and psychological wellbeing with a focus on negative emotions. For reasons I explained earlier, the physical and psychological reaction to a period of food deprivation gives us a comparable base for further understanding of the nature of our social needs. These complex internal processes are not easily displayed, and therefore animal studies are important to complement human research because they offer more options for randomization, intensity, and duration of experimental manipulations. However, although rodent studies offered great insights, many questions remain unanswered and need to be examined in humans (Matthews & Tye, 2019).

When looking at research conducted on humans so far, we can assume that the beforementioned long-term effects develop through a cumulation of short-term reactions we have little knowledge about (Tomova et al., 2020). The basic underlying biopsychological mechanisms remain open for discussion and exploration. One factor for mixed results so far is the lack of consistent terminology and methodology when considering social isolation and loneliness (Holt-Lundstad et al., 2015). Another blind spot in research on this topic is that most studies that report long-term effects of loneliness in humans were conducted in populations of elderly people, above the age of 59 years (Holt-Lundstad et al., 2015).

Due to the rising number of people feeling lonely and isolated in this global pandemic, finding answers to questions about the nature of loneliness will also help us find clinical implications and effective interventions to avoid damaging long-term consequences.

III. Hypotheses

The hypotheses that were tested in this study are as follows:

Research Question 1: Does loneliness build up progressively over time in a similar way to hunger?

H1.1. The level of hunger and the desire for food increase progressively over time during an eight-hour period of fasting.

H1.2. The level of loneliness and the desire for social contact increase progressively over time during an eight-hour period of social isolation.

My first set of hypotheses states that the desire for social contact and the desire for food built up progressively over time, meaning that the longer the period of deprivation lasts, either of social contact or food, the stronger the feeling of loneliness and hunger, the stronger the desire for social contact and the desire for food, respectively.

Research Question 2: Does social isolation affect subjective and physiological stress responses in a similar way to fasting?

H 2.1: The perceived level of stress will be higher after an eight-hour period of fasting, compared to an eight-hour period of satiety.

H 2.2: The perceived level of stress will be higher after an eight-hour period of social isolation, compared to an eight-hour period of social connection.

H 2.3: The increase of the cortisol level will be higher over an eight-hour long fasting period than over an eight-hour long sated period.

H 2.4: The increase of the cortisol level will be higher over an eight-hour long socially isolated period than over an eight-hour long socially connected period.

My second set of hypotheses states that the perceived stress response (measured with self-report questionnaires), as well as the physiological stress response (measured through salivary cortisol) is higher in both the social isolation condition and the hunger condition than in the neutral condition.

Research Question 3: Does social isolation affect (specific) mood states over time in a similar way to fasting?

H 3.1: The perceived level of negative mood is higher after an eight-hour period of fasting, compared to an eight-hour period of satiety.

H 3.2.: The perceived level of negative mood is higher after an eight-hour period of social isolation, compared to an eight-hour period of social connection.

H 3.3: The level of agitation is higher after an eight-hour period of fasting, compared to an eight-hour period of satiety.

H 3.4: The level of agitation is higher after an eight-hour period of social isolation, compared to an eight-hour period of social connection.

H 3.5: The level of fatigue is higher after an eight-hour period of fasting, compared to an eight-hour period of satiety.

H 3.6: The level of fatigue is higher after an eight-hour period of social isolation, compared to an eight-hour period of social connection.

H 3.7: The level of anger is higher after an eight-hour period of fasting, compared to an eight-hour period of satiety.

H 3.8: The level of anger is higher after an eight-hour period of social isolation, compared to an eight-hour period of social connection.

My third set of hypotheses states that social isolation and fasting both affect specific mood states, meaning that both conditions compared to the neutral condition will show higher rates of negative mood and agitation in the participants, as well as higher levels of fatigue and anger.

IV. Methods

The described hypotheses have been researched as part of a study by the clinical and social neuroscience unit (CSNU) at the University of Vienna. The experiment took place in the facilities of the Department of Psychology (Liebiggasse 5, 1090 Vienna). The aim of the study was to investigate motivational states that follow a period of social aversive states and a period of non-social aversive states. The aforementioned hypotheses investigate only a part of the entire study, but to be able to present a complete picture of the collected data I described

the whole procedure in short, with emphasis on my specific research questions and hypotheses.

Ethics

The University of Vienna's ethical committee approved all experimental procedures and the study was performed in accordance with the Declaration of Helsinki (World Health Organization, 2013). Participation was entirely voluntarily, and each individual was informed that she was free to withdraw from the study and exit the experimental setting at all times.

Sample

Due to the lack of published studies on the topic of short-term effects of social isolation in humans, the nature of our study was experimental. With the alpha error probability of $\alpha = .05$ and medium effect size of eta squared $\eta^2 = .06$, the minimal required number of participants was 28. Considering a dropout rate of 10%, we tested 30 participants (Faul et al., 2007).

The participants were recruited through online advertisements, through an electronic subject recruitment system of the Faculty of Psychology (<https://labs-univie.sona-systems.com>), as well as through social media and email. Additionally, flyers hung in the buildings of the University of Vienna, as well as the notification board of the Psychology department.

Phase one of our study consisted of an online questionnaire to assess the eligibility for our study. The questionnaire contained parts of the UCLA Loneliness Scale (Russell et al., 1980), the Social Isolation Index (adapted by Grant et al., 2009), and the Eating Disorder Examination Questionnaire (EDE-Q; Hilbert et al.; Rø et al., 2015). All participants recruited ($N = 30$) were healthy female adults in the age range of 18- 33 ($M = 22.57$, $SD = 3.05$). Due to gender-related changes in the salivary related stress hormone cortisol (Strahler et al., 2017), a much larger sample would have been needed with mixed male and female participants. Therefore, we decided to only recruit women. Because of the hormonal changes in cortisol levels across the menstruation cycle (Kudielka et al., 2009), we only recruited participants who used hormonal contraception, such as birth-control pills or a hormonal IUD.

We did not test during their withdrawal bleeding period or nursing. The study was conducted in German, therefore, all participants were fluent in German (C1 Level/Mother tongue). The participants' weight was within the BMI (Body Mass Index) range of 18-25 ($M = 21.03$, $SD = 2.21$). Because individuals with an eating disorder might show atypical reactions to fasting, we excluded anyone with critical rates in the EDE-Q (Rø et al., 2015).

We excluded everyone with a current psychiatric or neurological disorder, as well as users of medication that effects endocrine functioning. The participants were non-smokers and non-users of alcohol or drugs. Participants with severely high degrees of loneliness, as measured by the UCLA loneliness scale (Russell et al., 1980), and high rates of objective social isolation, measured with the Social Isolation Index (adapted from Grant et al., 2009), were excluded.

Participants recruited after March 2020 needed to fill out an additional questionnaire regarding changed inclusion criteria due to the global pandemic caused by SARS-CoV-2.

After the global Covid-19 pandemic started in March 2020, the inclusion criteria slightly changed in terms of the level of loneliness, therefore the phase one online questionnaire contained more questions. A number of $N = 8$ participants were tested before the pandemic, and a number of $N = 22$ after the pandemic.

Each participant signed a form of consent before participating that described all experimental procedures and was compensated with 180€ after performing three full experimental sessions and 15€ additionally for extra saliva samples the day after the sessions.

Phase One: The Online Questionnaire

The following questionnaires were used to assess eligibility of participants. Data about socioeconomic background, age, education, and relationship status was collected during this process.

The **Eating Disorder Examination Questionnaire** (EDE-Q; Hilbert et al., 2007) was used to examine eating behaviors and exclude participants with a high probability of an eating disorder. The scale included 22 items and four factors (*“restraint”*, *“eating concern”*, *“weight concern”* and *“shape concern”*), which were marked on a 7-point Likert scale (0 –

“not one day”, 1 – “1-5 days”, 2 – “6-12 days”, 3 – “13-15 days”, 4 – “16-22 days”, 5 – “23-27 days”, and 6 – “every day”).

The **UCLA Loneliness Scale** (Lamm & Stephan, 1986) was used to exclude persons with a heightened level of loneliness, through a scale of 20 items (from 1 – “*I never feel this way*” to 4 – “*I often feel this way*”) on a 4-point Likert scale.

The **Social Isolation Index** (Grant et al., 2009) assessed the frequency of social contacts.

The **Big-Five-Personality Test** (B5T) (Satow, 2012) was used to assess the participants’ level of extraversion, as that might influence their reaction to social isolation. From the five subscales of the inventory, only the extraversion subscale was used, in which participants rated 10 statements on a 4-point Likert scale (form 1: “*does not apply to me at all*” to 4: “*applies to me completely*”).

Phase Two: Experimental Procedure

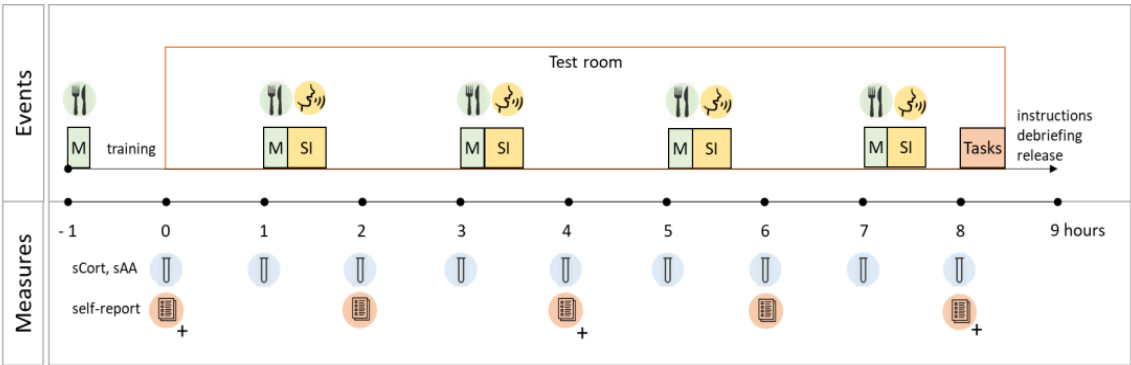


Figure 1. The neutral condition and its timeline. M = meal; SI = social interaction; sCort = salivary cortisol; sAA = salivary alpha amylase; Tasks = reward learning task, approach/avoidance task. The questionnaires for moods and motivational states were conducted every two hours. Additional mood states were measured every four hours. There were no meals in the hunger condition, while all other factors remained the same. There was no social interaction in the social isolation condition, while all other factors remained the same.

We applied a within-subject factorial design with one factor for conductance of the study (motivational state: neutral, non-social aversive, social aversive) and a within-subject

factorial design with two factors for analysis (motivational state and time: nine time points for the physiological measurements and five for the self-report measures).

The second phase contained three experimental sessions. Each participant had to undergo all three sessions: the neutral condition, the non-social aversive condition, and the social aversive condition. Each session lasted around 10 hours, including the time needed for preparation and instruction. A representation is shown in Figure 1.

The order of the given conditions was chosen randomly. We ensured that the three sessions of one person occurred within 7-21 days ($M = 9.85$, $SD = 3.38$).

Three sessions were held with each participant, all were organized in the same way, and therefore were similar beside the experimental induction (neutral/fasting/social isolation). The “neutral condition”, was used as a measurement for the baseline stress response and motivational state, included food and social contact. The non-social aversive condition contained social contact but no food, and therefore was considered as the “hunger condition”. The social aversive condition included food, but no social contact, and therefore was considered the “social isolation condition”.

The neutral condition contained meals as well as episodes of social contact. The caloric intake of the day was about 1320 kcal, spread over four meals, which were received every two hours. The meals arrived on a table in front of the testing room and were prepared by the experimenter beforehand. Additionally, there were four conversation slots of 30 minutes every two hours. Participants received a Nokia phone and a laptop to either call their family and friends or skype with them. Conversation slots were organized beforehand to ensure that the social interaction lasted for 30 minutes. These devices had to be picked up by the participant according to the schedule on a table in front of the testing room, prepared by the experimenter.

In the social isolation condition, the procedure contained the described meals every two hours, but no social interaction. The hunger condition contained no meals after breakfast, while social contact periods remained the same as in the neutral condition.

Shortly after arrival, participants filled out the morning questionnaire, answering questions in regard to their levels of stress, exercise, and health behaviors the days before the sessions. Each session started after an overnight period of fasting. Shortly after arrival each participant received the same breakfast (300 kcal) at 10 am, independent of the session’s

preset condition. After the procedure was explained and the extraction of the correct amount of saliva sample was collected, the participants underwent a short practice session for how they should behave and how to complete each task on a timely basis. The tasks included approach/avoid and executive function tasks.

As an ecological assessment (EMA) device, an iPhone was used to lead the participants through the sessions by alarms and instructions about the upcoming tasks and self-report questionnaires. The participants received a signal every hour to provide the saliva sample, and every second hour to provide the self-report questionnaire. A short manual was given in addition to ensure participants had all necessary information at hand.

After the preparation time, the participants spent eight hours in the “testing room”, which was comfortably set up and contained leisure activities, such as books and magazines—however, the activities were monitored not to include content related to any social mechanism. Each participant could bring three to five activities from home, which were checked beforehand for any social content. These ranged from knitting material to musical instruments to study material. Electronic devices were not allowed and there was no internet connection available. Exercising, meditating, and sleeping were not allowed during the experiment due the effects of these activities on the overall stress response.

The room was equipped with a safety camera without any audio or recording function, so the experimenter could check if the participants were safe, and the procedure done correctly. After eight hours of the session, the participants went into the separate “task room” to go through cognitive behavioral tasks, such as approach behavior and executive functioning tasks for about 50 minutes. After this was finished, the experimenter checked on the participant, prompted her on the saliva samples that were to be collected the day after, and finished the session.

Experimental Measurements: Physiological Data

Salivary cortisol was used as a measure of HPA-activity, and a biomarker of psychological stress and salivary alpha-amylase as a representation of stress-induced changes in the ANS (Nater et al., 2006), accompanied by the recording of the heartbeat, by using a chest strap Polar H10 (Polar Electro, Finland) (Shaffer & Ginsberg, 2017).

In order to measure cortisol and alpha-amylase levels, we collected saliva samples using SaliCap via passive drool method (IBL International, Hamburg, Germany). During each experimental session we took nine samples, and the day after each session we took two samples, which corresponds to 33 saliva samples per participant in total. The participants were asked to accumulate saliva for two minutes in their mouth and afterwards transfer the collected saliva into a vial using a straw. The saliva samples were stored at -20° before the biochemical analyses were conducted in the laboratory. By using commercial luminescence immunosorbent assay, free cortisol concentration in saliva was detected (LUM; IBL International, Hamburg, Germany). By using a kinetic colorimetric test and reagents obtained from DiaSys Diagnostic Systems, salivary alpha-amylase activity was measured (Holzheim, Germany). 10% of the sample was analysed in duplicate assays, and 90% in singlets according to IBL standards (IBL International, Hamburg, Germany).

Experimental Measurements: Self-Report Measurements

The mood and motivational states of the participants were explored five times during the day (hours: 0, +2, +4, +6, +8). Among other questionnaires used in the broader context of the experiment, I specifically analyzed the following:

The **desire for food**, as well as the **desire for social contact**, were measured with a questionnaire adapted from measuring the urge for cigarettes (Cox, Tiffany & Christen, 2011), in which participants estimated the degree of desire on a visual analogous scale (VAS) from “*not at all*” on the left to “*extremely*” on the right. These scales were expected to show increased desire for either food or social contact depending on the condition to ensure the experimental induction worked in the way intended.

Single-item rating on the perceived level of **loneliness**, **hunger**, and **stress** were used to explore the subjective stress response on a VAS (adapted from Dawans et al., 2011).

The **Multidimensional Mood Questionnaire** (MDBF; short form A, Steyer, Notz, Schwenkmetzger & Eid, 2003), contains a scale of 12 adjectives rated on a 5-point Likert scale (1 – “*not at all*” to 5 – “*very much*”), measuring three subscales (good – bad mood, alertness – tiredness, calmness – restlessness), and was used to measure the overall affective states of the participants while looking at valence and two types of arousal (energetic and tense arousal).

We used a short version of the **Profile of Mood States** (POMS; Heuchert & MacNair, 2012), which uses 19 adjectives on a 7-point Likert scale (1 – “*not at all*”, 7 – “*very strongly*”), divided into five subscales (sadness, hopelessness, tiredness, positive mood, and anger). These measurements were used to explore the specific effect of fasting and social isolation on anger (MacCormack & Lindquist, 2019).

Analysis

The program IBM SPSS Statistics 27 for Windows was used for all statistical analysis. *Two-way repeated measures Analyses of Variance* (ANOVA) were used for all hypotheses, followed by *simple effects analyses* using Bonferroni alpha-correction. The conditions and measurement timepoints were within-subject factors and the measures of interest was the dependent variable. The significance level was defined in advance as $\alpha = 0.05$ and the standardized effect size η^2 was used to evaluate the practical relevance of the results with .01 for small, .06 for medium, and .14 for large effects (Field, 2013). The descriptive statistical representation was based on the *mean value (M)* and *standard error (SE)*.

Assumptions

Prerequisites of our analysis were examined before the analysis. A boxplot was used to check for outliers, but the minor outliers that were found did not affect the outcome of the analysis, so they were not excluded in the main analysis. Some of the variables did not meet the requirement of normal distribution, but due to the robustness of the ANOVA this did not affect the procedure of analysis. Sphericity was tested by Mauchly's test and in case of correction the factor ϵ was used.

V. Results

Research Question 1: Does the desire for social contact build up progressively over time in a similar way to the desire for food?

H1.1. The desire for food increases progressively over time during an eight-hour period of fasting.

Mauchly's test indicated that the assumption of sphericity had been violated for the main effects of condition, $\chi^2(2) = 13.34$, $p < .001$ and the interaction of condition and time $\chi^2(2) = 64.00$, $p = .002$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .76$ for the main effect of condition and $\varepsilon = .66$ for the interaction effect of condition and time).

There was a significant main effect of the condition on the desire for food, $F(1.45, 42.06) = 66.51$, $p < .001$, $\eta^2 = .70$. Contrasts revealed that the desire for food was significantly higher in the hunger condition ($M = 51.72$, $SE = 3.22$) compared to the neutral condition ($M = 16.94$, $SE = 4.12$), $F(1, 29) = 78.54$, $p < .001$, $\eta^2 = .74$. Contrasts also show that the desire for food was not significantly higher in the social isolation condition compared to the neutral condition.

There was a significant main effect of time on the desire for food, $F(4, 116) = 36.92$, $p < .001$, $\eta^2 = .56$. Contrasts revealed that the desire for food was over all conditions significantly higher at the eight hour point of the experimental session ($M = 42.67$, $SE = 4.32$) compared to the beginning of the session ($M = 9.53$, $SE = 2.56$), $F(1, 29) = 105.46$, $p < .001$, $\eta^2 = .58$.

There was a significant effect of the interaction of time and condition, $F(5.25, 152.23) = 46.90$, $p < .001$, $\eta^2 = .62$. This indicates that the conditions had a different effect on the desire for food. Pairwise post-hoc comparisons with Bonferroni correction revealed that the increase of desire for food became significant in the four hour point of the hunger condition compared to the neutral and social isolation condition ($M = 29.88$, $SE = 3.13$), $p < .001$ and remained significantly higher until the eight hour point ($M = 42.67$, $SE = 4.32$), $p < .001$.

The steadily growing desire for food showed significant differences between almost all measurement timepoints within the hunger condition, which indicated that the state of hunger built up progressively. However, it showed a plateau, without a significant change in

desire ($p = .232$) from the four hour point ($M = 29.88$, $SE = 3.13$) to the six hour point ($M = 36.10$, $SE = 4.18$), and a trend towards increasing desire for food when we compare the time interval between the six and the eight hour point ($M = 42.67$, $SE = 4.32$), $p = .061$. Furthermore, pairwise post-hoc comparisons with Bonferroni correction revealed a significant difference between the measurement in the beginning of the session and the measurement after the second hour point in all three conditions, indicating that the desire for food was a progressively built state that declined after consuming a meal (see Table 1 and Figure 2). Contrasts showed that there was no significant difference between the beginning of the session and the eight hour point when we compared the social isolation condition and the neutral condition.

Table 1

Means and standard errors for the desire for food.

Condition			Neutral	Hunger	Social Isolation
Hours after the Session Started	0	<i>M</i>	9.67	8.20	10.73
		<i>SE</i>	3.44	2.67	3.70
	2	<i>M</i>	25.30	29.37	30.67
		<i>SE</i>	5.58	5.06	5.72
	4	<i>M</i>	11.33	64.27	14.03
		<i>SE</i>	3.76	3.88	4.52
	6	<i>M</i>	15.27	72.13	20.83
		<i>SE</i>	5.25	4.75	5.36
	8	<i>M</i>	23.13	84.63	20.23
		<i>SE</i>	6.01	4.35	5.19

Note. *M* and *SE* represent mean and standard error, respectively

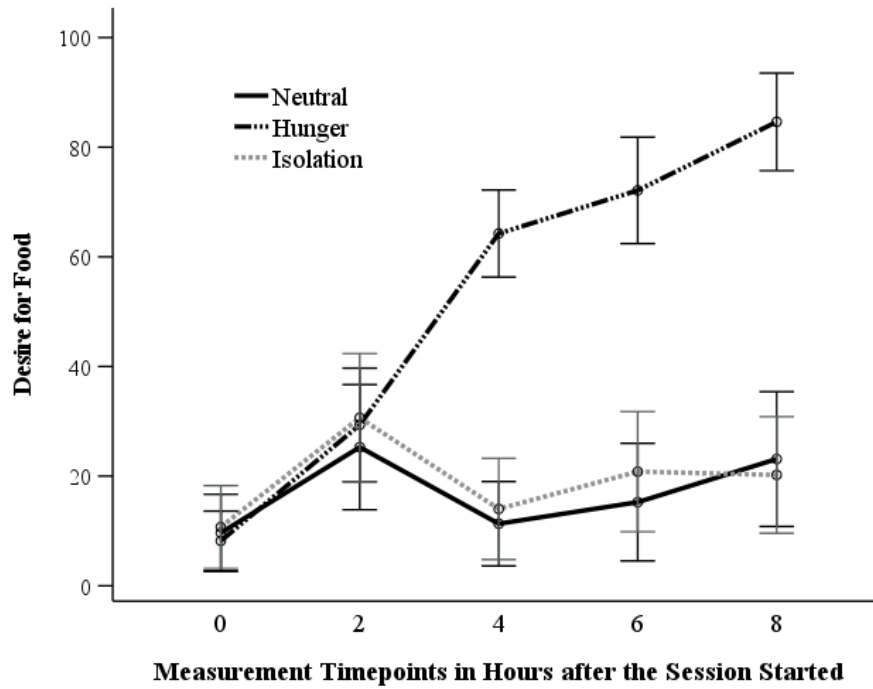


Figure 2. Significant interaction effect between condition and time for the desire for food. Error bars represent 95% confidence intervals

H1.2. The desire for social contact increases progressively over time during an eight-hour period of social isolation.

Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of time, $\chi^2(2) = 38.11, p < .001$, and the interaction of condition and time $\chi^2(2) = 75.06, p < .001$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .61$ for the main effect of time and $\varepsilon = .66$ for the interaction effect of condition and time).

There was a significant main effect of the condition, $F(2, 58) = 6.72, p = .002, \eta^2 = .19$. Contrasts revealed that the desire for social contact was significantly higher in the social isolation condition ($M = 38.50, SE = 4.78$) than in the neutral condition ($M = 24.31, SE = 4.21$), $F(1, 29) = 13.98, p < .001, \eta^2 = .32$. Contrasts also showed no significant difference between the hunger condition and the neutral condition.

There was a significant main effect for time, $F(2.44, 70.77) = 20.70, p < .001, \eta^2 = .42$. Contrasts revealed that the desire for social contact was overall significantly higher at the eight hour point ($M = 41.33, SE = 4.48$) than at the beginning of the session ($M = 21.08, SE = 3.68$), $F(1, 29) = 44.24, p < .001, \eta^2 = .61$.

There was a significant interaction effect between the different conditions and the timepoints, $F(5.26, 152.65) = 2.76, p = .018, \eta^2 = .09$. Pairwise post-hoc comparisons with Bonferroni correction revealed that the desire for social contact was significantly higher in the social isolation condition compared to the other two conditions at the four hour point ($M = 41.20, SE = 5.66$) $p < .001$, and remained significantly higher until the eight hour point ($M = 52.13, SE = 5.53$), $p = .013$. Post-hoc tests revealed that the difference in desire for social contact became significant and remained significant, when comparing all three conditions, after the four hour point ($M = 41.20, SE = 5.66$), $p < .001$. There was no significant difference for the hunger and the neutral condition when we compared the measurement at the beginning of the session and the measurement that was taken at the eight hour point. Although there were no significant differences between the measurement timepoints within the neutral condition we could see a trend towards a significant increase of desire for social contact at the end of the day, at the eight hour point ($M = 33.00, SE = 5.52$), $p = .053$. When looking at the hunger condition there was a significant increase in desire for social contact after eight hours ($M = 38.87, SE = 5.98$), $p = .013$ compared to the beginning of the session.

When breaking down the difference between the measurement timepoints there was a trend of heightened desire for social contact in all three conditions, especially towards the eight hour point (see Table 2). Figure 3 shows a plateau between hour six and hour eight in the neutral and hunger condition, but not the social isolation condition. These effects reflect that the social isolation condition resulted in a significantly higher rate of desire for social contact than the neutral condition and the hunger condition. We can also see that the desire for social contact progressively grew over the course of the day in each condition.

Table 2

Means and standard errors for the desire for social contact

Condition			Neutral	Hunger	Social Isolation
Hours after the Session Started	0	<i>M</i>	19.87	21.00	22.37
		<i>SE</i>	4.35	4.47	4.96
	2	<i>M</i>	22.57	28.93	30.83
		<i>SE</i>	4.41	4.61	5.03
	4	<i>M</i>	20.93	25.50	41.20
		<i>SE</i>	5.11	4.53	5.66
	6	<i>M</i>	25.20	27.50	45.97
		<i>SE</i>	5.49	5.13	5.69
	8	<i>M</i>	33.00	38.87	52.13
		<i>SE</i>	5.52	5.98	5.53

Note. *M* and *SE* represent mean and standard error, respectively

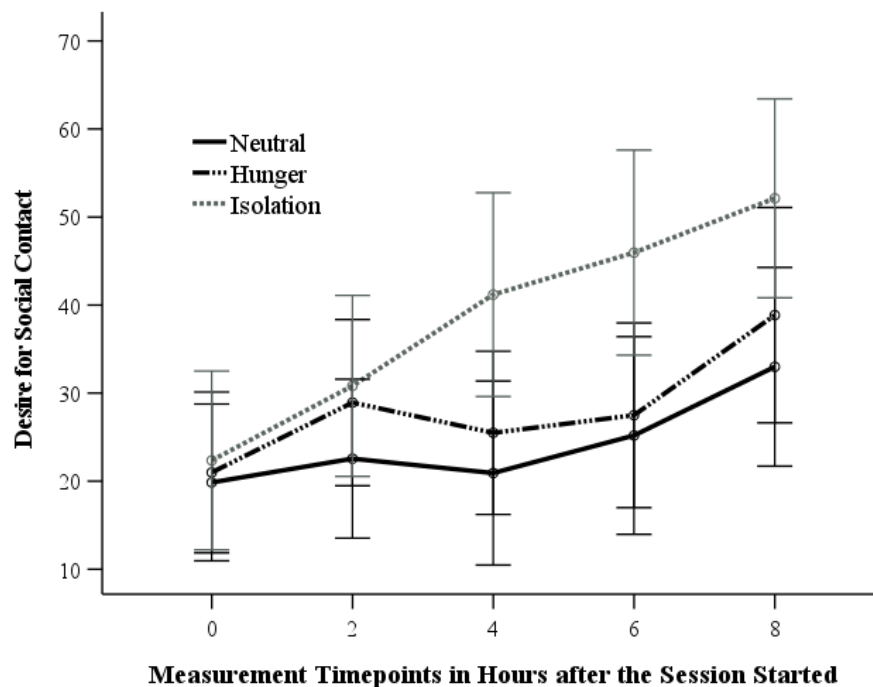


Figure 3. Significant interaction effect between condition and time for the desire for social contact. Error bars represent 95% confidence intervals

Research Question 2: Does social isolation affect the subjective and physiological stress responses in a similar way to fasting?

H 2.1: The perceived level of stress will be higher after an eight-hour period of fasting, compared to an eight-hour period of satiety.

H 2.2: The perceived level of stress will be higher after an eight-hour period of social isolation, compared to an eight-hour period in the neutral condition.

Mauchly's test indicated that the assumption of sphericity had been violated for the main effects of time, $\chi^2(2) = 89.51, p < .001$, and the interaction of condition and time $\chi^2(2) = 286.92, p < .001$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\epsilon = .49$ for the main effect of time and $\epsilon = .48$ for the interaction effect of condition and time).

There was no significant main effect of the condition on the perceived level of stress, $F(2, 58) = 0.73, p = .489$, no significant main effect of different measurement timepoints on the perceived level of stress, $F(3.92, 113.67) = 2.41, p = .054$, and there was no significant interaction between the condition and time on the perceived level of stress, $F(7.65, 221.78) = 1.05, p = .402$.

H2.3: The increase of the cortisol level will be higher over an eight-hour long fasting period than over an eight-hour long period of satiety.

H2.4: The increase of the cortisol level will be higher over an eight-hour long socially isolated period than over an eight-hour long period in the neutral condition.

Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of condition, $\chi^2(2) = 13.24, p = .001$, and time, $\chi^2(2) = 323.92, p < .001$, as well as the interaction of condition and time $\chi^2(2) = 456.42, p < .001$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\epsilon = .73$ for the main effect of condition, $\epsilon = .24$ for the main effect of time, and $\epsilon = .22$ for the interaction between condition and time).

There was no significant main effect of the different conditions on the level of cortisol, $F(1.45, 42.13) = 0.74, p = .444$.

There was a significant main effect of the different time measurement points on the level of cortisol, $F(1.89, 54.71) = 32.91, p < .001$. Contrasts revealed that the cortisol level was overall significantly higher in the beginning of the session ($M = 5.14, SE = 0.49$) than at the eight hour point ($M = 1.63, SE = 0.21$), $F(1, 29) = 49.28, p < .001, \eta^2 = .63$. The cortisol level peaked in the neutral condition ($M = 3.04, SE = 0.45$) and social isolation condition ($M = 2.77, SE = 0.27$) at the five hour point, shortly after a meal was consumed.

There was no significant interaction effect between the conditions and the time measurement points, $F(3.49, 101.27) = 1.84, p = .136$.

The interaction graph (Figure 4) shows that the level of salivary cortisol decreased progressively in the hunger condition and mostly in the neutral and social isolation condition. A peak at the five hour point in the neutral and isolation condition shows a sudden increase in cortisol, right after lunch was consumed. After that short peak, the cortisol level went down again and slowly declined over the course of the upcoming measurement timepoints. Breaking down the differences between the timepoints, we see a significant decline of cortisol level in each condition from the beginning to the four hour point, and we see a significant change between the hunger condition and the other two conditions. The cortisol level continued declining in the hunger condition, just as before.

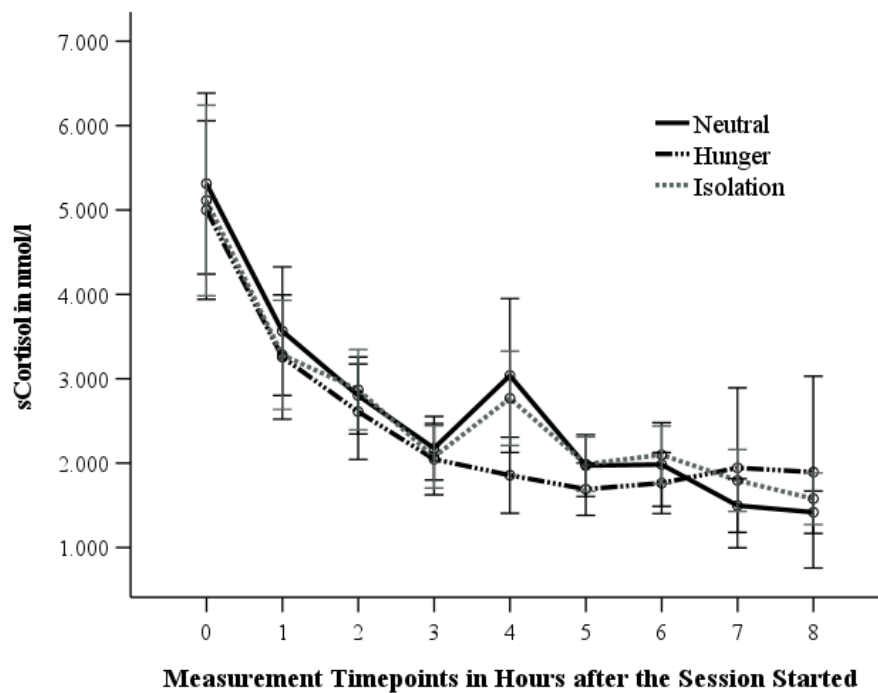


Figure 4. Significant effect of time for the salivary cortisol measurement. Error bars represent 95% confidence intervals

Research Question 3: Does social isolation affect (specific) mood states over time in a similar way to fasting?

H 3.1: The mood is worse after an eight-hour period of fasting, compared to an eight-hour period of satiety.

H3.2.: The mood is worse after an eight-hour period of social isolation, compared to an eight-hour period in the neutral condition.

Mauchly's test indicated that the assumption of sphericity had been violated for the interaction of condition and time $\chi^2(2) = 58.81, p = .008$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .70$).

There was a significant main effect of the condition, $F(2, 58) = 4.96, p = .010$. Contrasts revealed that the mood states of the participants were significantly affected in the hunger condition ($M = 15.46, SE = 0.51$), compared to the neutral condition ($M = 16.85, SE = 0.41$), $F(1, 29) = 13.48, p < .001, \eta^2 = .31$, meaning that the participants in the hunger

conditions reported higher rates of negative mood, but there was no significant difference between the social isolation condition and the neutral condition.

There was a significant main effect of different measurement timepoints, $F(3.28, 95.19) = 12.65, p < .001$. Contrasts revealed that there was a significant change of mood when we compare the beginning of the session ($M = 16.60, SE = 0.43$) and the end of the session at the eight hour point ($M = 15.22, SE = 0.48$), $F(1,29) = 17.17, p < .001, \eta^2 = .37$. This indicates that participants were in a significantly worse mood eight hours after the session started than at the beginning. Contrasts revealed that there was a significant decrease in mood states at the four hour point ($M = 2.10, SE = 0.16$) and five hour point ($M = 2.56, SE = 0.27$). The mood was significantly worse at the end of the session than at the beginning. The interaction of condition and time was not significant, $F(5.56, 161.62) = 2.07, p = .065$.

As shown in Figure 5, the valence of the mood state of the participants was becoming more negative over the course of the experimental session at the four hour point. We can see that the mood was overall better in the neutral condition than in the other two conditions. Both the neutral and the hunger condition showed a relatively steep and sudden drop in mood from the four hour point to the six hour point. This decline is less drastic in the social isolation condition, which showed the flattest curve and less variance.

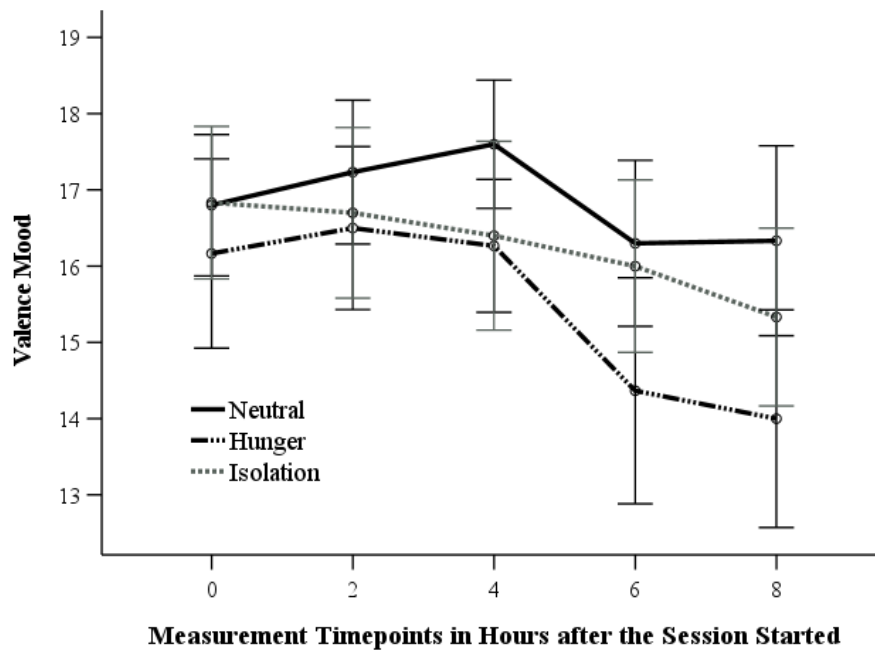


Figure 5. Significant effect of condition and significant effect of time for the valence of mood. Error bars represent 95% confidence intervals

H3.3: The level of agitation is higher after an eight-hour period of fasting, compared to an eight-hour period of satiety.

H3.4: The level of agitation is higher after an eight-hour period of social isolation, compared to an eight-hour period in the neutral condition.

Mauchly's test indicated that the assumption of sphericity had been violated for the main effects of time, $\chi^2(2) = 25.93, p = .002$, and the interaction of condition and time $\chi^2(2) = 50.50, p = .046$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\epsilon = .73$ for the main effect of time and $\epsilon = .67$ for the interaction effect of condition and time).

The main effect of condition showed no significant difference in the level of agitation, $F(2, 58) = 2.79, p = .069$. However, when looking at the contrasts we can see that the difference between the hunger condition ($M = 15.17, SE = 0.50$) and the neutral condition ($M = 16.01, SE = 0.45$) was significant $F(1, 29) = 4.24, p = .048, \eta^2 = .13$, but not the difference between the social isolation and the neutral condition.

The main effect of time showed a significant difference in the level of agitation of the participants, $F(2.89, 84.07) = 8.43, p < .001$. Contrasts revealed that there was a significant difference in agitation between the beginning of the session ($M = 16.14, SE = 0.45$) and the eight hour point ($M = 14.48, SE = 0.48$), $F(1, 29) = 12.21, p = .002, \eta^2 = .29$. This indicates that the participants became more agitated over time. We also see that participants showed a significant decrease of calmness at the eight hour point ($M = 14.48, SE = 0.58$), $F(1, 29) = 12.21, p = .002, \eta^2 = .30$, compared to the first measurement point.

There was no significant interaction effect of the condition and time on the perceived level of agitation, $F(5.37, 155.75) = 1.54, p = .176$.

The interaction graph (Figure 6) shows that the calmness was higher at the beginning of the session for all three conditions than at the end. This indicates that the participants became more agitated over time. There was no significant difference between the neutral and the social isolation condition, but the hunger condition showed overall lower rates of calmness. There was an overall decrease of calmness at the eight hour point.

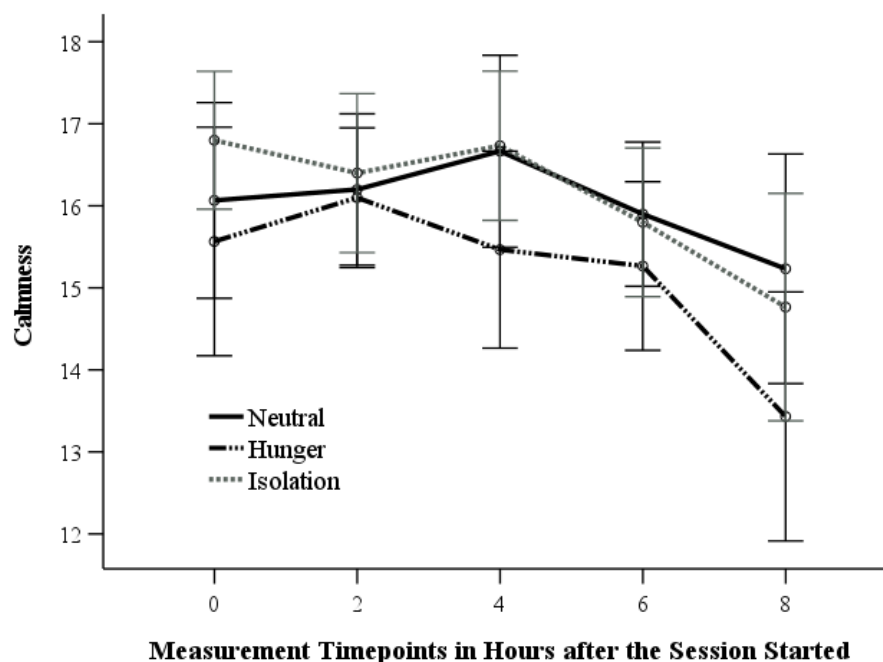


Figure 6. Significant main effect of time on calmness. Error bars represent 95% confidence intervals

H3.5: The level of energetic arousal is lower after an eight-hour period of fasting, compared to an eight-hour period of satiety.

H3.6: The level of energetic arousal is lower after an eight-hour period of social isolation, compared to an eight-hour period in the neutral condition.

Mauchly's test indicated that the assumption of sphericity had been violated for time $\chi^2(2) = 19.23, p = .024$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .72$).

The main effect of the condition on the energetic arousal was significant, $F(2, 58) = 9.70, p < .001$. Contrasts revealed that the hunger condition ($M = 13.39, SE = 0.47$) showed a significant effect compared to the neutral condition ($M = 14.66, SE = .46$), $F(1, 29) = 10.27, p = .003, \eta^2 = .26$. This indicates that participants perceived higher energy levels in the neutral condition than in the hunger condition. There was also a significant difference between the isolation condition ($M = 12.93, SE = 0.47$) and the neutral condition ($M = 14.66, SE = 0.46$), $F(1, 29) = 16.86, p < .001, \eta^2 = .37$. This indicates that participants had higher rates of energy level in the neutral condition than in the social isolation condition.

The main effect of time on the energetic arousal was significant, $F(2.88, 83.46) = 6.06, p < .001$. Contrasts revealed that there was a significant effect of time on the energetic arousal when we compared the first measurement timepoint ($M = 14.10, SE = 0.57$) and the last measurement timepoint, at the eight hour point ($M = 12.61, SE = 0.50$), $F(1, 29) = 5.78, p < .023, \eta^2 = .17$. This indicates that the energetic arousal declined over the course of the day. Contrasts revealed that the difference of energetic arousal only became significant at the eight hour point, but showed a trend of increasement at the six hour point ($M = 13.06, SE = 0.53$), $F(1, 29) = 3.82, p = .060, \eta^2 = .12$.

The main effect of the interaction between condition and time was not significant, $F(8, 232) = 1.11, p = .360$.

The interaction graph (Figure 7) reveals that the overall energetic arousal was the highest in the neutral condition. The energetic arousal in the neutral condition was comparable with the hunger condition in its course. There were no significant changes in energetic arousal in the social isolation condition, and the curve looks overall less steep than in the other two conditions and shows a trend of slowly declining energy levels.

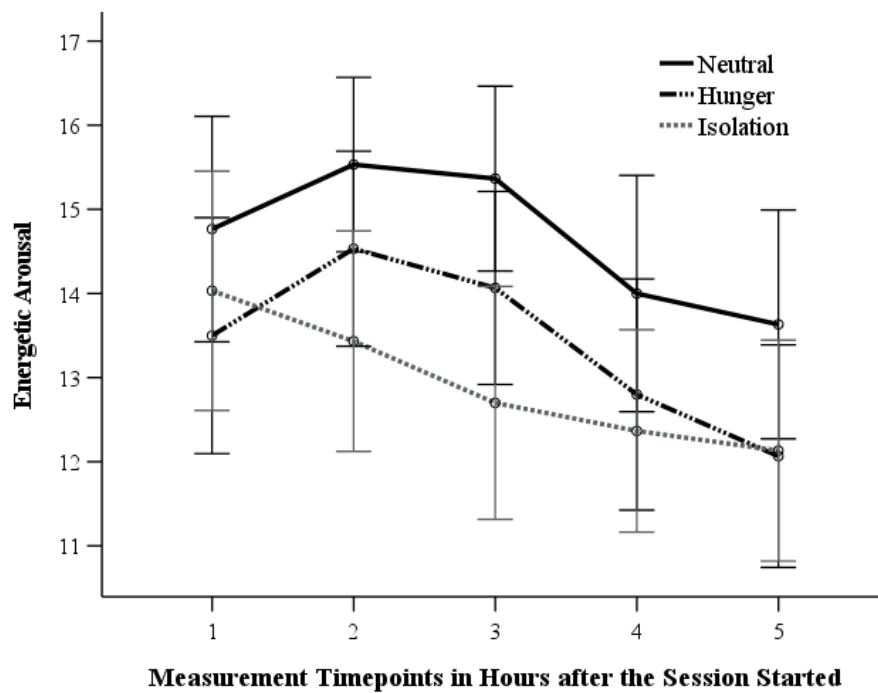


Figure 7. Significant main effect of condition and significant main effect of time on the energetic arousal. Error bars represent 95% confidence intervals

H3.7: The level of anger is higher after an eight-hour period of fasting, compared to an eight-hour period of satiety.

H3.8: The level of anger is higher after an eight-hour period of social isolation, compared to an eight-hour period in the neutral condition.

One participant had to be excluded for analysis due to unrecorded values on the anger scale, so the sample size for this calculation included 29 participants. Mauchly's test indicated that the assumption of sphericity had been violated for the main effects of time, $\chi^2(2) = 7.18, p = .028$ and the interaction of condition and time, $\chi^2(2) = 44.57, p < .001$. Therefore, degrees of freedom were corrected using Huynh-Feldt estimates ($\epsilon = .81$ for the main effect of time) and Greenhouse-Geisser estimates of sphericity ($\epsilon = .72$) for the interaction effect of condition and time.

There was no significant main effect of the conditions, $F(2, 56) = 0.77, p = .466$, no significant main effect of the timepoints, $F(1.71, 47.79) = 0.74, p = .462$, and no significant interaction effect of the conditions and measurement timepoints on the perceived level of anger, $F(2.88, 80.76) = 0.96, p = .413$.

VI. Discussion

The aim of this study was to gain a better understanding of the processes involved in the physical and psychological response to the state of food deprivation and the state of social deprivation. For this purpose, we chose 30 young, female participants, who underwent three experimental sessions, which contained aversive and non-aversive motivational states. We measured the desire for food and social contact, we examined the physiological and psychological level of stress, and we observed their emotional states, such as valence, energetic arousal, calmness, and anger throughout the procedure.

Desire for Food and Social Contact

My first research question explored how hunger and loneliness develop in a state of deprivation. The results show that both the desire for food and the desire for social contact were heightened under the state of specific deprivation, which supports the hypothesis that the desire for social contact builds up progressively in a similar way to the desire for food.

When observing the desire for food (see Figure 2) we can see that the difference in desire became significant after the fourth hour of the session, which marks the time when lunch was served in the neutral and social isolation condition. It makes sense that the desire for food grew before noon in all conditions given the expectation for a meal at lunchtime. The desire for food thereafter declined to a non-significant level in the sated conditions, which indicates a healthy homeostatic process (Atasoy et al., 2012). The steadily growing desire for food in the hunger condition confirms the hypothesis that hunger is a progressively built state, which arises in the context of deprivation (Herbert et al., 2012; Tomova et al., 2020; Chen et al., 2016). When looking at the desire for social contact (see Figure 3), we can also see a significantly heightened desire in the social isolation condition, which progressively built up over the course of the day. This confirms the hypothesis that the feeling of loneliness represents, just like the feeling of hunger, a steadily growing desire within a state of deprivation, which indicates that similar homeostatic regulation mechanisms are involved in both deprivation states (Tomova et al., 2020; Cacioppo, 2016). Although there is a significant difference in desire for social contact in the different conditions, we can also see a trend towards increasing desire for social contact in the neutral and the hunger condition. One explanation for this might be that the need for social contact is more complex

than the experimental study anticipated, meaning that social contact in the form of phone calls or skype conversations does not fulfill crucial aspects of our social needs, such as touch, body language, and facial expressions (Hertenstein et al., 2006; Cacioppo et al., 2015; Gazzola et al., 2012). One important implication of this observation is that the uprising levels of loneliness might be intensified by the means of technological communication tools that do not emphasize these aspects. This could be a lesson to prioritize the quality of social interactions and not the quantity of our digital socializing (Anderson & Thayer, 2018).

Stress

My second research question explored the physiological and the psychological stress response to the state of food deprivation and social isolation. We measured participants' stress level by examining levels of salivary cortisol, as well as through their own subjectively perceived level of stress.

Looking at the perceived level of stress, we do not see any significant changes due to the hunger or social isolation condition. This might be an indicator that the experimental induction was not perceived as acutely stressful for the participants. The foresight of seeing friends after the session and having a meal at home might have taken away the threat caused by deprivation. Another explanation might be that the exclusion criteria for the study already chose participants who would not be stressed by the deprivation states of hunger and social isolation. Additionally, all participants were healthy and young, so they might be more resilient towards stressors than other, more vulnerable parts of the population.

When looking at the physiological measurement of cortisol, we can see in Figure 4 that we have an overall pattern of a flattening curve in all three conditions. The small peak of rising cortisol levels in the social isolation condition and the neutral condition in the fifth hour of the study can be explained by consuming a meal, which is usually followed by a heightened cortisol response (Schlotz, 2019). Cortisol levels show diurnal variations, they are highest in the morning and lowest after midnight, which represents a “normal” cortisol distribution (Cacioppo & Cacioppo, 2018). We neither see a significant effect of the conditions nor a significant interaction of conditions with time, which might indicate that the experimental induction was not activating a stress response as we expected. This makes sense in combination with perceived level of stress, which was not significant, although it is also

important to keep in mind that a lot of times the physiological measurements of stress are not necessarily correlated with the perceived levels of stress (Campagne, 2019).

This lack of conclusive evidence could mean that the deprivation states of hunger and social isolation were not perceived as stressful due to their predictability and short-term duration. A clear end was in sight for our participants, which may have allowed them to stave off high levels of stress or panic. Another reason could be that the interpretation of the cortisol level alone as an indicator of the biological stress response remains insufficient due to the complexity of the multifaceted stress response and the large amount of variance in cortisol levels that lies within individuals (Schlotz, 2019; Strahler et al., 2017). Moreover, physical activity, nutritional intake, and sleeping habits have a huge impact on cortisol rates. The sample size could have simply been too small to uncover significant changes. In measuring the physiological stress response we have to examine the activity in two main stress-response axes, the HPA-axis and the ANS (Bear et al., 2016). So far, research has shown that the activity of both mentioned systems was increased while being socially isolated in other mammals (McNeal, 2014). While a drop in blood sugar levels facilitates the activity of the ANS, it becomes unclear how the HPA-axis might be affected, if at all (Cross et al., 2004; Strahler et al., 2017). Since only the cortisol levels were analyzed as a measurement of the HPA-activity, the interpretation of the stress response needs to be taken with a grain of salt and combined additional measures, such as salivary alpha-amylase and heartrate, become more insightful than cortisol alone (McNeal, 2014; Strahler et al., 2017; Schlotz, 2019). McNeal et al. (2014) presented evidence that the state of loneliness leads to immediate response in the heartrate activity in prairie voles, which indicates that future research needs to emphasize the use of measurements of the ANS, such as heartrate or skin conductance.

Another reason why interpreting cortisol must be done with caution is that stressful situations usually cause a peak in cortisol levels 15 minutes after a stressful event has occurred (Schlotz, 2019), which is a short and specific period of time. This was difficult to measure in our study design because we did not have short and sudden stressors. We created slowly progressing states of deprivation, which were highly predictable.

Additionally, we are facing a contradictory body of stress in the context of hunger (Gonzales-Bono et al., 2002). Studies about the relationship between HPA-activity and states of fasting present evidence that both satiated and fasted states can enhance HPA-activity (Rohleder & Kirschbaum, 2007). Stress can change the eating behavior and food can change

the perception of a stressful event (Chen et al., 2016). Mechanisms involved in the modulation of the stress response remain unclear, which makes it difficult to evaluate the role of stress and cortisol in the state of hunger.

It is important to also examine the CAR when observing alterations in the HPA-activity after a phase of short-term deprivation (Cacioppo & Cacioppo, 2018). Studies have shown that the immediate response of the HPA-axis might not be detected in the cortisol level, but an alteration of the CAR can be an indicator of stress in the form of chronic isolation (Cacioppo & Cacioppo, 2018). Studies about the short-term stress response in humans are scarce and further research is needed (Tomova et al., 2020).

Emotion

In my third research question I addressed the emotional and energetic changes induced by a state of deprivation. The fasting condition did have a negative impact on the mood state of the participants as expected. As it can be seen in Figure 5, the mood was more positive in the neutral condition than in the hunger and social isolation condition. This is in line with research we have so far on the consequences of food deprivation, proving that hunger causes general negative effects (MacCormack & Lindquist, 2019; Herbert et al., 2012). We could not find a significant effect of the social isolation condition on the valence of the mood. The social isolation condition showed overall less variance, and although we can see a trend of heightened negative mood in the social isolation condition in Figure 5, it is difficult to draw conclusions from that. One explanation for the lack of a significant finding might be that negative affect caused by social isolation builds up more slowly than when caused by hunger. The sudden drop of glucose while hungry sends a strong biological signal, which might be more subtle in regard to social isolation.

When interpreting the level of agitation, we can see in Figure 6 that the participants were, independent of the conditions, calmer at the beginning of the sessions than at the end. There was no significant difference between the neutral and the social isolation condition, but the hunger condition showed overall higher rates of agitation. One explanation for the heightened level of agitation in all experimental inductions is the lack of movement and external stimulation, such as daylight and fresh air. One explanation for the heightened level of agitation in the hunger condition might be a sense of nervous energy, as caused by a

growing desire for food, and the expectation for a meal after the session ends. The hypothesis of higher rates of agitation in the state of hunger was significant, although not during social isolation.

When it comes to energetic arousal, we can see (Figure 7) that the overall energetic arousal is highest in the neutral condition. Both conditions lead to significantly lower levels of energetic arousal than the neutral condition. The hypothesis that the energetic arousal would be affected by states of deprivation can be seen in this area of the study. Both conditions ended in very low levels of energetic arousal. One explanation for this might be that a lack of resources and energetic supplies triggered a homeostatic response that signaled to the body that a lower energetic output is needed for longer maintenance of the given resources (Ramsay & Woods, 2014).

Although we see an effect on the valence mood states of the participants in the hunger condition, we could not detect any states of anger. Neither the hunger condition nor the social isolation condition led to higher rates of anger, as it was stated in my prior hypotheses. That could be explained by the muting effect of affect labeling (MacCormack & Lindquist, 2019). Research has shown that the emotional intensity of a state goes significantly down when it is being labeled, due to reduced activity in the amygdala (MacCormack & Lindquist, 2019). Another explanation might be that context creates the tonus of an emotional experience. That means that the lack of negative stimuli or threatening stimuli while hungry or isolated in this study led to non-significant findings of anger. A different situational context might still be able to increase levels of anger in a state of deprivation. Alternatively, “only” a state of glucose deprivation might not lead to anger, but the state of glucose-deprivation in combination with a social threat might amplify unpleasant feelings when homeostasis is threatened in multiple ways (MacCormack & Lindquist, 2019).

Conclusion

Both states of deprivation—hunger and social isolation—led to increased desire for the specific need in similar ways in terms of time-related properties. These results are in line with research in the field of homeostatic circuits and the motivational drive triggered by an energetic deficit (Matthews & Tye, 2019, Tomova et al., 2020). Although this study did not find significant changes in the physiological and psychological level of stress, this does not

mean that the previously stated hypotheses about the connection between fasting and stress, as well as isolation and stress, does not exist. As explained before, several reasons might have caused the lack of significant findings and they need extensive future research.

The emotional outcomes of this experiment show a connection between negative affect, lower energy, and lower levels of calmness— specifically in the case of food deprivation. Social isolation showed a trend of altered mood and decreased calmness compared to the neutral condition, and a significant effect on the energetic arousal, which could be explained by allostatic processes involved in social needs.

Although the results of the perceived level of stress and the measured cortisol level do not show clear evidence of an immediate short-term effect of social isolation, we do see effects on the mood, the desire, the level of agitation, and arousal. This might be explained by the small sample size and the predictability of the design.

Limitations

Due to the exploratory nature of this experiment, the sample size was quite small with only 30 participants. Additionally, we recruited only young, female participants who were using hormonal contraception, and all of whom came from a similar Central European background—consequently making it difficult to draw general conclusions. Hormonal changes and gender might be crucial factors when considering the stress reactivity and emotional response. Due to the “wear and tear” of homeostatic processes and long-term consequences of loneliness found specifically in the elderly, the results of this study might not be representative. Furthermore, the exclusion criteria might have tailored the study to attract participants with higher levels of resilience towards food related and social stressors, and therefore they may have reacted less pronounced towards the given stimuli. Factors such as personality traits, e.g. the level of extraversion and social environment have a significant impact on the perception of loneliness as well.

The predictability of the testing schedule and the superficial laboratory setting are limiting factors in the interpretability of this study. A natural environment, such as the participants’ private apartments, would be an insightful location for future research and grant higher ecological validity. A reason why it might have been less stressful than under “normal” circumstances is that the participants knew when the period of deprivation would

end. The impact would probably be more significant if participants were isolated for a longer period of time and with no knowledge of when the trial would end.

In the larger context of the study, more measures were conducted and analyzed that give more insight on the matter. Cortisol responses are not as easy to evaluate and further examinations, specifically of the CAR demand future investigation.

There was no “normal” movement possible, and typically, people walk around much more, which affects our metabolism and the sensation of hunger. Just as the feeling of hunger under these superficial circumstances might not be completely representative of a “normal” day, the sort of social contact which could be given under the experimental circumstances did not include factors like touch and body language, which might take away an important factor of social connectivity we usually experience.

The COVID-19 pandemic began after we started recruiting and testing participants, which made it difficult to evaluate if there were changes in stress reactivity and emotional responsiveness due to the pandemic. People are now generally more used to social isolation than they were before. Technological means of communication are more widespread than ever before. And the overall exhaustion of the population due to political measurements such as lockdowns, enforcement of wearing masks, and physical distancing might have changed the overall emotional states of the participants and their stress level/stress perception. We must admit that we do not know yet how the pandemic will influence stress reactions and mood long-term.

Considering the importance of social needs and the immense practical and clinical implications that are awaiting us in an upcoming pandemic of loneliness, much more investigation will be needed. Regardless of its limitations, this study contributed to the field of research we have on the nature of short-term stressors and the relevance of understanding social needs on a biological and psychological level.

Future Research and Current Relevance

Research about loneliness was already a quickly developing field before the global COVID-19 pandemic hit, but it drastically gained more relevance than we could have imagined. Physical distancing and heavy restrictions of our social lives led to sudden peaks of social isolation for all members of society. Consequences of this pandemic can already be

seen in rising depression rates and an increased amount of people who are struggling with anxieties (Bzdok & Dunbar, 2020). Social isolation does have a more significant impact on our physical and psychological well-being than one might think. Scientific proof that social connections can impact our stress response and leave marks on our system is crucial in incorporating this growing understanding about our innate social needs. This research not only offers ideas for preventive measures in dealing with mental health issues but can also serve as an accessible resource in treating people who already suffer from chronic loneliness. Research possibilities give us a chance to address changes in the way we structure our social lives and the perspective we have on our mental health. The importance of communities and social work, as well as clinical interventions such as group therapy and mindfulness exercises, need to be considered in further research. Long-term consequences of the pandemic on loneliness can be addressed in connection with stress management and inclusivity. Technology can offer a great opportunity but cannot replace real human contact. We know that physical touch, and real-time interaction plays a huge part in the function of social contact (Hertenstein et al., 2006; Gazzola et al., 2012).

As Tomova et al. (2020) have done in their experiment with a neuroimaging approach, we need to add more diverse methodological approaches that focus on recording short-term effects of deprivation in humans, with special attention towards CAR and additional ANS stress measures, such as the heart rate. There is a lot of potential to understand the complex mechanisms followed by hunger and social isolation. Unpredictable periods of social isolation and fasting could give us stronger insights into the stress responses we already saw in rodent studies; however, this remains difficult to achieve due to ethical standards in human research.

As aforementioned, future research needs to focus on larger sample sizes, with mixed gender, more various age groups, different occupational backgrounds, and a more diverse cultural representation. The cultural perception of community structure will highlight how stressful isolation is perceived differently. Intercultural studies can give us better access to how social circuits build up through environmental influences, such as an emphasis on stronger family structures in Eastern countries versus a more individualistic approach in the Western Hemisphere. Important questions can be examined when we ask the question if stronger family bonds and social connections make us more resilient towards the stressor of short-term isolation, or if they actually make us more prone to a stronger short-term reaction.

Another important insight can be gained from investigating the impact of social isolation and stress in correlation with personality traits such as extraversion and neuroticism.

It is clear that social needs are crucial for the physical and mental health of humans. Still, we must consider that social interactions are complex and multifaceted, and therefore we must be careful with the usage of technological communication tools that lack essential elements of in-person socializing. This experimental study offers a ground on which future research can be oriented, so that we can deepen our knowledge for the underlying biological mechanisms of loneliness and find solutions to consequences of disconnection.

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Abstract English

When humans and animals are deprived of their basic needs, such as nutritional supplies or social connections, a homeostatic response is triggered, which impacts physiological functioning and behaviors. Long-term states of deprivation can lead to chronic imbalances and stress, which further result in detrimental physiological and psychological health implications. Although research has shown that there are severe consequences of loneliness, the underlying mechanisms of homeostatic regulation and altered stress reactivity in humans are not yet understood. To investigate the immediate response to a short-term state of social deprivation and food deprivation our study compared the perceived level of stress, the cortisol levels, the affective changes, as well as the desire for the deprived need (food; social contact) of 30 participants ($N = 30$) in three experimental conditions (social isolation, fasting, neutral). Results showed that a mandated period of fasting and social isolation (8h) led to a significant increase in the desire for the deprived need. We did not find any significant effects on the level of salivary cortisol and no differences in the perceived level of stress. The fasting condition led to significantly worse mood, higher levels of agitation, and lower energetic arousal as expected, but no change in anger. Surprisingly, we did not find significant changes in mood and the levels of agitation in the social isolation condition—only the energetic arousal was negatively affected. Overall, the results implicate that states of deprivation lead to homeostatic changes that impact our behavior. Although the results on the stress levels were not significant, further investigations with more diverse stress measurements are needed to gain a better understanding of psychopathological impairments due to chronic states of loneliness.

Keywords: homeostasis/deprivation, stress, hunger, social isolation, emotions

Abstract German

Wenn sich Menschen und Tiere in einem Zustand des Mangels befinden, wie zum Beispiel einem Nahrungsentzug oder sozialer Isolierung, wird eine homöostatische Antwort getriggert, die sich auf physiologische Funktionen und Verhaltensweisen auswirkt. Lange Phasen der Entbehrung können zu chronischem Ungleichgewicht und Stress führen, welche wiederum mit negativen Auswirkungen auf unsere physische und psychische Gesundheit einhergehen. Obwohl es viel Forschung bezüglich der ernstzunehmenden Konsequenzen chronischer Einsamkeit gibt, sind die zugrundeliegenden homöostatischen Mechanismen bisher unbekannt und die Zusammenhänge mit der Stressreaktanz nicht geklärt. Um die unmittelbare Reaktion auf kurze Phasen des Fastens und der sozialen Isolation zu untersuchen und zu vergleichen, haben wir das subjektive Stressempfinden, die Kortisol Werte, Veränderungen des Affekts und das Verlangen nach dem entbehrten Bedürfnis (Nahrung; sozialer Kontakt) bei 30 Teilnehmerinnen ($N = 30$) in drei experimentellen Bedingungen (Fasten, soziale Isolation, Neutral) untersucht. Die Ergebnisse zeigen, dass eine Periode des Fastens und der sozialen Isolation (8h) zu einem erhöhten Verlangen nach dem entbehrten Bedürfnis geführt hat. Es konnten weder signifikante Veränderungen bei den Kortisol Werten noch bei dem subjektiven Stressempfinden festgestellt werden. Die experimentelle Bedingung des Fastens hat zu signifikant schlechterer Stimmung, erhöhter Unruhe und niedrigerem Energieniveau geführt, sie hatte allerdings keine Auswirkung auf die Emotion Wut. Überraschenderweise führte die Bedingung der sozialen Isolation nicht zu emotionalen Veränderungen—lediglich das Energieniveau wurde negativ beeinflusst. Zusammengefasst implizieren diese Ergebnisse, dass ein Zustand der Deprivation homöostatische Veränderungen hervorruft, die einen Einfluss auf unser Verhalten haben. Obwohl die Ergebnisse der Stresserhebungen nicht signifikant waren, brauchen wir in Zukunft vielfältigere Methoden der Stresserfassung, um die psychopathologischen Beeinträchtigungen, die durch chronische Einsamkeit entstehen besser zu verstehen.

Schlüsselbegriffe: Homöostase/Deprivation, Stress, Hunger, soziale Isolation, Emotionen

Experimental Informed Consent

Der Einfluss von sozialen und nicht sozialen Bedürfnissen auf den körperlichen Zustand -
TeilnehmerInneninformation und Einwilligungserklärung

TeilnehmerInneninformation und Einwilligungserklärung zur Teilnahme an der Studie:

Der Einfluss von sozialen und nicht sozialen Bedürfnissen auf den körperlichen Zustand

Sehr geehrte(r) Teilnehmer(in),

Wir laden Sie ein, an der oben genannten Studie teilzunehmen.

Ihre Teilnahme an dieser Studie erfolgt freiwillig. Sie können jederzeit ohne Angabe von Gründen aus der Studie ausscheiden. Die Ablehnung der Teilnahme oder ein vorzeitiges Ausscheiden aus dieser Studie hat keine nachteiligen Folgen für Sie.

Diese Art von Studien ist notwendig, um verlässliche neue wissenschaftliche Forschungsergebnisse zu gewinnen. Unverzichtbare Voraussetzung für die Durchführung von Studien ist jedoch, dass Sie Ihr Einverständnis zur Teilnahme an dieser Studie schriftlich erklären.

Bitte lesen Sie den folgenden Text als Ergänzung zum Informationsgespräch mit dem/der StudienleiterIn sorgfältig durch und zögern Sie nicht, Fragen zu stellen.

Bitte unterschreiben Sie die Einwilligungserklärung nur

- wenn Sie Art und Ablauf der Studie vollständig verstanden haben,
- wenn Sie bereit sind, der Teilnahme zuzustimmen,
- wenn Sie sich über Ihre Rechte als TeilnehmerIn an dieser Studie im Klaren sind.

1. Was ist der Zweck der Studie?

Das Ziel der Studie ist die Untersuchung der Schwankungen der Stresshormone Cortisol und Alpha Amylase im Tagesverlauf. Diese werden während drei motivationalen Zuständen gemessen: (1) im Laufe eines normalen Tages, (2) im Laufe eines Tages mit verringerter Kalorienaufnahme und (3) im Laufe eines Tages mit verringertem sozialem Kontakt. Wir sind interessiert daran, wie die hormonellen Veränderungen mit Ihren persönlichen Erfahrungen in Beziehung stehen.

Bitte lesen Sie dieses Dokument aufmerksam durch und fragen Sie bei Unklarheiten nach, bevor Sie Ihr Einverständnis zur Studienteilnahme erteilen.

2. Wie läuft die Studie ab?

Die Studie findet in der Fakultät für Psychologie, Universität Wien, Liebiggasse 5, 1010 Wien, statt. Es werden insgesamt 30 Personen (Alter 18 bis 35 Jahre) daran teilnehmen.

Vor der Teilnahme an der Studie werden potentielle TeilnehmerInnen gebeten einen Online-Fragebogen auszufüllen. Dabei werden diese auf das Zutreffen aller Einschlusskriterien und das Fehlen aller Ausschlusskriterien hin überprüft. Der Online-Fragebogen wird weiter einige vorbereitende psychologische Fragebögen beinhalten. Anschließend bekommen alle

Teilnehmenden die Möglichkeit, allgemeine Fragen zur Studie und zum Design zu stellen. Wenn Sie als TeilnehmerIn für die Studie zulässig sind, werden drei Termine mit Ihnen im Labor der Fakultät für Psychologie vereinbart.

Die Studie besteht aus drei Sitzungen. Jede Sitzung dauert 10 Stunden (insgesamt 30 Stunden). In einer von drei Sitzungen werden Sie nur in der Vorbereitungsphase Essen erhalten, nicht aber während der Testphase (Bedingung der verringerten Kalorienaufnahme). In einer anderen Sitzung werden Sie während der Testphase keinen sozialen Kontakt haben (Bedingung des verringerten sozialen Kontakts). In der dritten Sitzung werden Sie in der Vorbereitungsphase und in der Testphase sowohl Essen als auch sozialen Kontakt haben (Neutrale Bedingung). Die Reihenfolge der Bedingungen wird per Zufall zugeteilt. Am Folgetag jeder Sitzung werden Sie gebeten zwei weitere kurze Messungen zu Hause durchzuführen und diese bei der nächsten Sitzung oder an einem anderen vereinbarten Termin abzugeben.

Ablauf einer Sitzung

Die erste Sitzung startet mit einer Vorbereitungsphase von ca. 1 ½ Stunden. In der zweiten und dritten Sitzung wird die Vorbereitungsphase etwas kürzer sein. Am Anfang werden Sie ein Frühstück erhalten und einen psychologischen Fragebogen ausfüllen. Anschließend werden Sie vom/von der VersuchsleiterIn geschult die Messinstrumente selbstständig zu benutzen. Die Messinstrumente beinhalten: Die Salicaps zum Sammeln der Speichelproben, das Ecological Momentary Assessment Device (EMA), über welches die Fragebögen beantwortet werden, und den Gürtel, welcher Ihre Herzfrequenz misst. Am Ende der 1 ½-stündigen Vorbereitungsphase werden wir Sie um die erste selbstständige Messung (bestehend aus Speichelprobe und Fragebögen) bitten.

Auf die Vorbereitungsphase folgt die Testphase. Diese wird 8 Stunden dauern. Sie werden gebeten, Ihre persönlichen Gegenstände im Vorbereitungsraum zu lassen. Das ist notwendig, um die Bedingungen für alle Teilnehmenden so ähnlich und vergleichbar wie möglich zu halten. Außerdem können Sie drei bis fünf Gegenstände von zu Hause als Beschäftigungsmöglichkeit mitbringen. Dabei darf es sich nicht um elektronische Geräte (z.B. Handy, Laptop, I-Pod) oder soziale Inhalte handeln (z.B. Bilder von Gesichtern, Romane). Nähere Informationen zu den Gegenständen werden Sie von uns vor der Sitzung erhalten. Während der Testphase können Sie die Zeit so verbringen, wie Sie es möchten. Zusätzlich zu Ihren eigenen mitgebrachten Gegenständen stehen im Raum verschiedene Beschäftigungsmöglichkeiten (z.B. Bücher, Puzzles, Zeichenmaterial) zu Ihrer freien Verfügung. Ungefähr einmal in der Stunde wird das EMA Gerät Ihnen ein Signal geben (in Form eines Piepens) und Sie auffordern einen kurzen Fragebogen auszufüllen und eine Speichelprobe abzugeben. In den Sitzungen, bei denen Sie während der Testphase Mahlzeiten erhalten, wird Ihnen das Essen zu vorgegebenen Zeiten bereitgestellt. Für die Messung des Hormonspiegels ist es wichtig nur dann zu essen, wenn Sie dazu instruiert werden. In den Sitzungen, bei welchen Sie während der Testphase sozialen Kontakt haben, werden Sie den von Ihnen ausgewählten Gesprächspartnern via Skype und/oder Handy kommunizieren. Sie werden zu bestimmten Zeiten dafür mit einem Laptop und einem Handy ausgestattet (Wichtig: Es handelt sich dabei um Geräte der Universität, nicht Ihre eigenen). Sie werden vor der Sitzung noch nähere Informationen zur Absprache mit Ihren gewählten Kontakten erhalten. Während der Testphase ist die Kommunikation mit dem/der TestleiterIn nicht möglich, außer bei Notfällen oder der Entscheidung, die Studie abzubrechen. Aus diesem Grund wird der Raum mit einer Überwachungskamera ausgestattet, damit der/die TestleiterIn Ihr Wohlbefinden sicherstellen kann. Diese Kamera nimmt nicht auf und überträgt keinen Ton. Ihr Verhalten im Raum wird nicht analysiert.

Am Ende der Testphase werden Sie am Computer noch ein paar Tests durchführen, die aus zwei Teilen bestehen. Im ersten Teil wird Ihnen eine Reihe von Bildern präsentiert. Ihre Aufgabe ist es zu entscheiden, wie groß die Bilder auf dem Bildschirm sein sollen. Danach sollen Sie bewerten, wie sehr Ihnen die Bilder gefallen haben. Im zweiten Teil werden Sie eine Aufgabe zur

Bewegungskoordination, eine Aufgabe zum Arbeitsgedächtnis und eine Aufgabe zur Aufmerksamkeitskontrolle durchführen.

Nach Vollendung der Testphase erhalten sie Instruktionen für die Nachfolgephase (den Morgen nach der Testung). Diese Phase besteht aus zwei weiteren Messungen, die Sie selbstständig zu Hause durchführen. Sie werden gebeten, jeweils direkt nach dem Aufwachen und 30 Minuten nach dem Aufwachen einen kurzen Fragebogen auszufüllen und eine Speichelprobe abzugeben. Letztlich werden Sie gebeten, diese zu Ihrer nächsten Sitzung oder zu einem anderen vereinbarten Zeitpunkt in die Fakultät für Psychologie, Universität Wien, Liebiggasse 5, 1010 Wien, zu bringen.

3. Worin liegt der Nutzen einer Teilnahme an der Studie?

Die Teilnahme an dieser Studie hat für Sie persönlich keinen unmittelbaren Nutzen. Wir hoffen jedoch, dass die Ergebnisse dieser Studie uns weitere Einblicke in körperliche und emotionale Reaktionen auf Veränderungen in der Menge von Kalorienaufnahme und sozialem Kontakt auf täglicher Ebene liefern.

4. Gibt es Risiken, Beschwerden und Begleiterscheinungen?

Nein, die Teilnahme an der Studie ist nach menschlichem Ermessen mit keinen oder vernachlässigbaren Risiken assoziiert. Die Untersuchungen werden ohne Ausnahme von trainierten VersuchsleiterInnen durchgeführt. Es werden keine medikamentöse oder therapeutische Methoden zu Zwecken der Studie verwendet. Die oben beschriebenen Untersuchungen sind nicht-invasiv und wurden bereits ohne negative Konsequenzen durchgeführt.

5. Hat die Teilnahme an der Studie sonstige Auswirkungen auf die Lebensführung und welche Verpflichtungen ergeben sich daraus?

Wir bitten Sie:

- am Tag der Sitzung bevor Sie ins Labor kommen keinerlei Nahrung zu sich zu nehmen
 - 24 Stunden vor Beginn der Sitzungen keinen Kaugummi zu kauen,
 - eine Stunde vor Beginn der Sitzungen Ihre Zähne nicht zu putzen,
 - in den 18 Stunden vor den Sitzungen nicht zu rauchen oder koffeinhaltige Getränke (Kaffee, Cola, Tee), Säfte oder Alkohol zu konsumieren,
 - und 24 Stunden vor Beginn den Sitzungen keinen Sport mehr zu betreiben,
- da all diese Aktivitäten Einfluss auf die physiologischen Messungen haben könnten.

Dieselben Einschränkungen gelten auch für den Abend nach der Sitzung, bis zum Zeitpunkt der Nachfolgephase am nächsten Morgen.

6. Was ist zu tun beim Auftreten von Beschwerdesymptomen, unerwünschten Begleiterscheinungen und/oder Verletzungen?

Sollten im Verlauf der Studie unerwünschte Symptome, Begleiterscheinungen, Krankheiten oder Verletzungen auftreten, müssen Sie diese der Studienleitung und/oder den Mitarbeitenden umgehend mitteilen.

7. Wann wird die Studie vorzeitig beendet?

Sie können jederzeit, auch ohne Angabe von Gründen, Ihre Teilnahmebereitschaft widerrufen und aus der Studie ausscheiden, ohne dass Ihnen dadurch irgendwelche Nachteile entstehen.

Ihr/e StudienleiterIn wird Sie über alle neuen Erkenntnisse, die in Bezug auf diese Studie bekannt werden und für Sie wesentlich sein könnten, umgehend informieren. Auf dieser Basis können Sie dann Ihre Entscheidung zur weiteren Teilnahme an dieser Studie neu überdenken.

Es ist aber auch möglich, dass Ihr/e StudienleiterIn Ihre Teilnahme an der Studie vorzeitig beendet, ohne vorher Ihr Einverständnis einzuholen.

Die Gründe hierfür können sein:

- a) Sie können den Erfordernissen der Studie nicht entsprechen;
- b) Der/die StudienleiterIn hat den Eindruck, dass eine weitere Teilnahme an der Studie nicht in Ihrem Interesse ist.

Sollte Ihre Teilnahme an der Studie vorzeitig beendet werden (von Ihnen oder von der Studienleitung), werden Sie 10€ als Kompensation erhalten, falls keine der Sitzungen vollendet wurde. Sie erhalten 40€, falls bis zu diesem Zeitpunkt zumindest eine Sitzung vollendet wurde.

8. In welcher Weise werden die im Rahmen dieser Studie gesammelten Daten verwendet?

Ihre Daten werden pseudonymisiert (d.h. ohne Verweis auf Ihren Namen gespeichert), indem Ihnen eine ID Nummer zugeordnet wird. Für Personen ohne Zugang zu diesen persönlichen Informationen, wird es daher nicht möglich sein, Rückschlüsse auf Ihre Person zu ziehen. Vorbehaltlich anderslautender gesetzlicher Bestimmungen werden nur Mitglieder der Forschungsgruppe Zugang zu vertraulichen Daten mit persönlichen Informationen erhalten (Name, Vorname, Alter, Email). Diese werden in einem, von den anderen erhobenen Daten separaten Dokument auf einem sicheren, passwort-geschützten Computer gespeichert. Die Forschungsgruppenmitglieder unterliegen der Schweigepflicht.

Die komplette statistische Auswertung wird auf Basis der pseudonymisierten Daten erfolgen. In wissenschaftlichen Publikationen und Präsentationen werden nur die Gruppenergebnisse präsentiert und Sie werden niemals namentlich genannt. Das Dokument in welchem Ihre persönlichen Daten gesammelt werden, wird sobald alle Auswertungen abschlossen sind, zerstört. Alle anderen Daten werden in Übereinkunft mit den gesetzlichen Vorschriften gespeichert.

9. Entstehen für die TeilnehmerInnen Kosten? Gibt es einen Kostenersatz oder eine Vergütung?

Durch Ihre Teilnahme an dieser Studie entstehen für Sie keine Kosten. Als Vergütung für Ihren Zeitaufwand erhalten Sie nach erfolgter Teilnahme **180€**.

Falls Sie für die Studie geeignet sind und für die erste Sitzung erscheinen, diese aber nicht beenden, erhalten Sie ein „Erscheinungsentgelt“ von **10€**. Falls Sie mindestens eine, aber weniger als drei Sitzungen vollenden, erhalten Sie ein „Teilentgelt“ von **40€**. Wenn Sie alle drei Sitzungen vollenden erhalten Sie das gesamte Entgelt von **180€**.

Für jede vollendete *Nachfolgephase am nächsten Morgen* erhalten Sie zusätzliches Entgelt von jeweils **5€**. Dieses zusätzliche Geld kommt zu Ihrem Hauptentgelt am Ende Ihrer Teilnahme hinzu.

10. Möglichkeit zur Diskussion weiterer Fragen

Für weitere Fragen im Zusammenhang mit dieser Studie stehen Ihnen Ihre Studienleiterin und ihre MitarbeiterInnen gerne zur Verfügung. Auch Fragen, die Ihre Rechte als ProbandIn in dieser Studie betreffen, werden Ihnen gerne beantwortet.

Der Einfluss von sozialen und nicht sozialen Bedürfnissen auf den körperlichen Zustand -
TeilnehmerInneninformation und Einwilligungserklärung

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Einwilligungserklärung

Name der teilnehmenden Person in Druckbuchstaben:
Geb. Datum:

Ich erkläre mich bereit, an der Studie „Der Einfluss von sozialen und nicht sozialen Bedürfnissen auf den körperlichen Zustand“ teilzunehmen.

Ich bin von „.....“ (Name der aufklärenden Person) ausführlich und verständlich über Zielsetzung, Bedeutung und Tragweite der Studie und die sich für mich daraus ergebenden Anforderungen aufgeklärt worden. Ich habe darüber hinaus den Text dieser TeilnehmerInneninformation und Einwilligungserklärung gelesen, insbesondere den 4. Abschnitt (Gibt es Risiken, Beschwerden und Begleiterscheinungen?). Aufgetretene Fragen wurden mir von der Studienleitung verständlich und ausreichend beantwortet. Ich hatte genügend Zeit, mich zu entscheiden, ob ich an der Studie teilnehmen möchte. Ich habe zurzeit keine weiteren Fragen mehr.

Ich werde die Hinweise, die für die Durchführung der Studie erforderlich sind, befolgen, behalte mir jedoch das Recht vor, meine freiwillige Mitwirkung jederzeit zu beenden, ohne dass mir daraus Nachteile entstehen. Sollte ich aus der Studie ausscheiden wollen, so kann ich dies jederzeit schriftlich oder mündlich bei Dr. Giorgia Silani oder Ana Stijović veranlassen.

Ich bin zugleich damit einverstanden, dass meine im Rahmen dieser Studie erhobenen Daten aufgezeichnet und ausgewertet werden.

Ich stimme zu, dass meine Daten dauerhaft in pseudonymisierter Form elektronisch gespeichert werden. Die Daten werden in einer nur der Projektleitung zugänglichen Form gespeichert, die gemäß aktueller Standards gesichert ist.

Sollte ich zu einem späteren Zeitpunkt, die Löschung meiner Daten wünschen, so kann ich dies innerhalb der nächsten sechs Monate schriftlich oder telefonisch ohne Angabe von Gründen bei Dr. Giorgia Silani (E-Mail: giorgia.silani@univie.ac.at, Tel.: +43-1-4277-47223) oder Ana Stijović (E-Mail: ana.stijovic@univie.ac.at, Tel.: +43-1-4277-47235) veranlassen.

Den Aufklärungsteil habe ich gelesen und verstanden. Ich konnte im Aufklärungsgespräch alle mich interessierenden Fragen stellen. Sie wurden vollständig und verständlich beantwortet.

Eine Kopie dieser TeilnehmerInneninformation und Einwilligungserklärung habe ich erhalten. Das Original verbleibt bei der Studienleitung.

(Datum und Unterschrift der TeilnehmerIn)

.....

(Datum, Name und Unterschrift der Studienleitung)

.....

Experiment Fee Note

Timepoint (TO/T1): _____, Sosci: _____, ID: _____

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T +43-1-4277-47223

Aufwandsentschädigung

Hiermit bestätige ich, im Rahmen der Studie „Der Einfluss von sozialen und nicht sozialen Bedürfnissen auf den körperlichen Zustand“ (Studienleiterin Prof. Giorgia Silani) des Instituts für Klinische und Gesundheitspsychologie als freiwillige Versuchsperson an der Labortesting teilgenommen zu haben und ersuche um Überweisung von € _____ als Dankeschön für die Teilnahme.

Für die etwaige Versteuerung dieser Aufwandsentschädigung erkläre ich mich selbst verantwortlich.

IBAN: _____

BIC: _____

(nur bei ausländischen Konten)

Name: _____

Adresse: _____

Datum: _____

Unterschrift der Versuchsperson

Conversation Times

Während Ihrer Sitzung werden Sie 4 Gesprächszeiten haben, die jeweils 30 Minuten dauern. Sie werden Handy und Laptop der Universität für die Gespräche verwenden. Sie werden Zugang zu den Kontakten haben, die Sie in die untenstehende Tabelle eintragen. Alle Nummern die Sie unten eintragen, werden für kurze Zeit an dem Handy der Universität gespeichert und nach Ende Ihrer Sitzung sofort wieder gelöscht. Falls Sie möchten, werden Sie ebenfalls Ihren eigenen Skype-Account verwenden können und zu all Ihren Skype-Kontakten Zugang haben. Bitte vergewissern Sie sich vor der Sitzung, dass Sie ihren Skype-Username und Ihr Passwort für Skype parat haben.

Notieren Sie die Namen Ihrer Gesprächspartner in der Tabelle so, dass Sie sie später wiedererkennen (Spitznamen), daneben die Telefonnummer und den Skype-Namen (falls erforderlich). Notieren Sie zusätzlich einige Ersatzkontakte, die Sie anrufen können falls ein Gespräch frühzeitig beendet wird oder das geplante Gespräch nicht zustande kommt.

Bitte erinnern Sie Ihre Gesprächspartner noch vor der Sitzung an den Termin.

Informieren Sie Ihre Gesprächspartner, dass diese nicht mit Ihrem eigenen Handy angerufen werden. Das Handy der Universität hat eine anonyme Nummer. Daher wird bei einem eingehenden Anruf "Private number" auf dem Display Ihrer Gesprächspartner aufscheinen.

Die Struktur der Studie erlaubt keine Abweichungen der Gesprächstermine. Die von Ihnen gewählten Gesprächspartner müssen innerhalb der folgenden Gesprächszeiten verfügbar sein:

12:17-12:47

14:22-14:52

16:17-16:47

18:17-18:47

Sie können auch mit der gleichen Person zu verschiedenen Gesprächszeiten kommunizieren oder mit ein paar Personen innerhalb einer Gesprächszeit.

Bitte senden Sie uns den Gesprächszeitenplan spätestens 3 Tage vor der Sitzung zu. **Falls es zu Veränderungen bezüglich der Termine kommen sollte, informieren Sie uns bitte so schnell wie möglich!**

Dieser Plan dient Ihnen auch als Erinnerung während der Sitzung.

List of Activities

Zeitvertreib im Testraum

Bitte **NICHT** mitbringen:

- ❖ Handy, Tablet, Laptop, andere elektronische Geräte
- ❖ Lesestoff mit vorwiegend sozialen Inhalten
- ❖ Magazine und Zeitungen mit Fotos von Gesichtern und Romane
- ❖ Laute Instrumente z.B. Trompete, Saxophon
- ❖ Material zur sportlichen Betätigung z.B. Gewichte, Yogamatte, ...

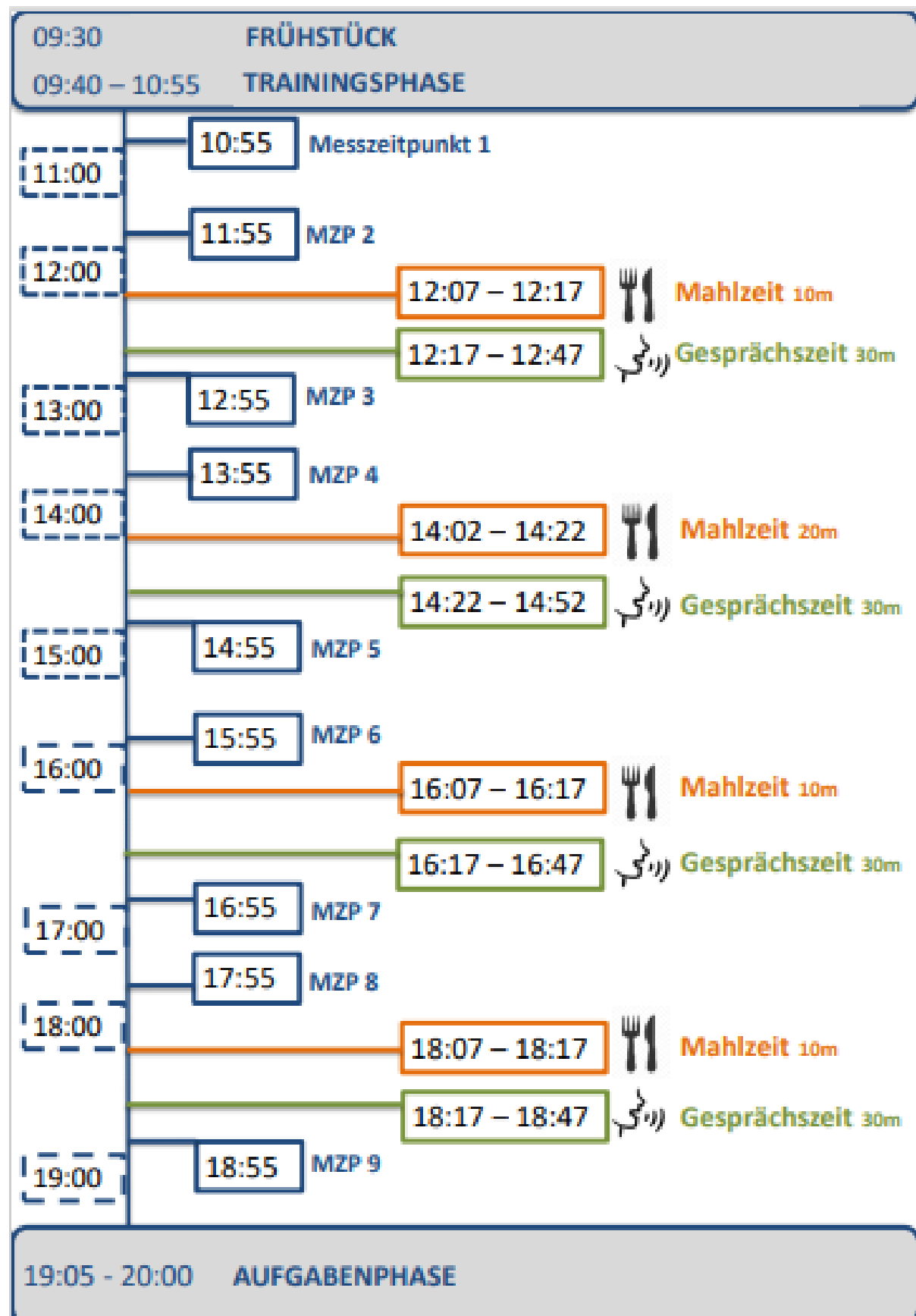


Mitbringen **ERLAUBT**:

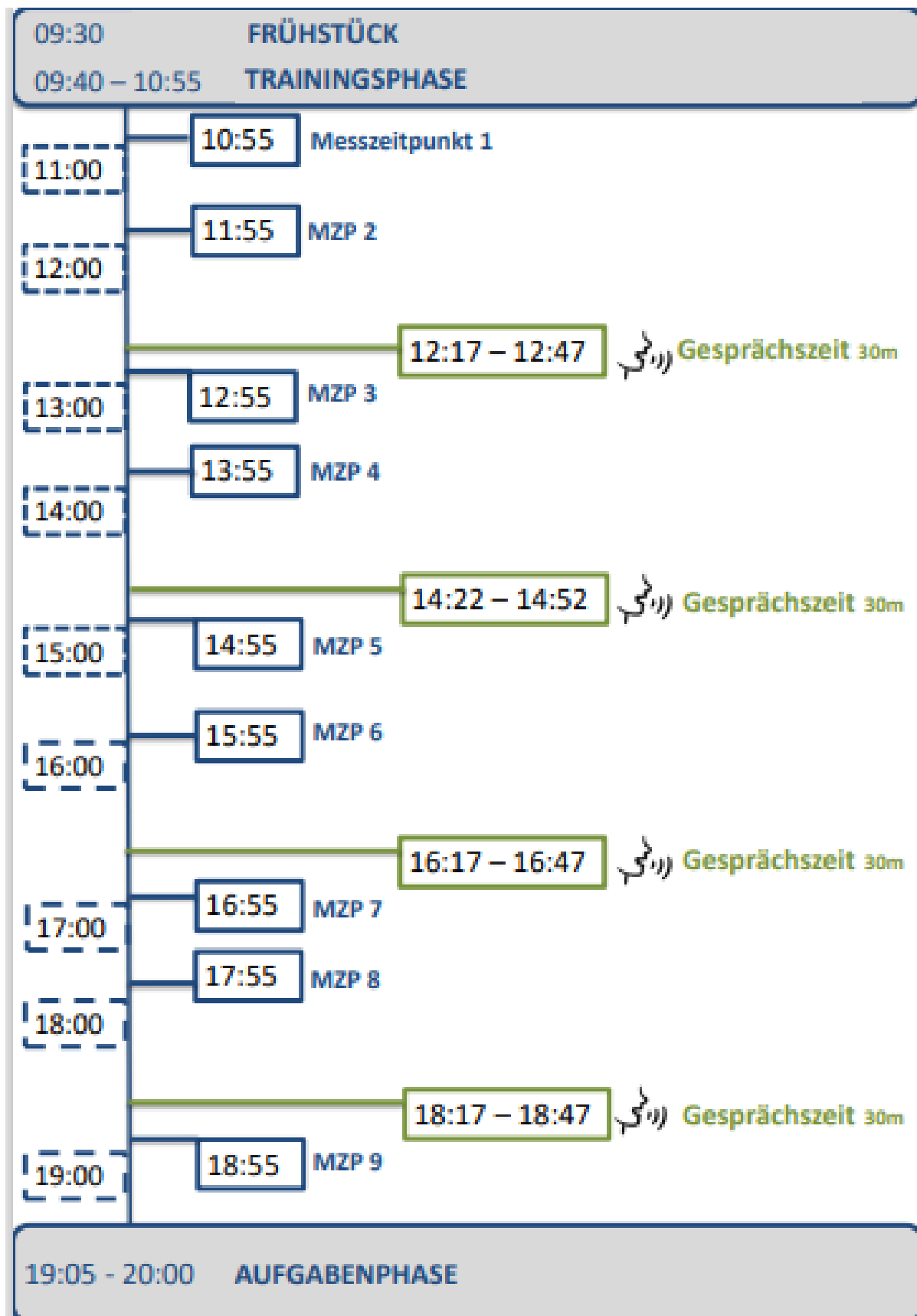
- ❖ Lesestoff ohne soziale Inhalte (ohne Bilder von Gesichtern): Lehbücher, Magazine über Natur, Sachbücher, ...
- ❖ Puzzles, Rätsel, ...
- ❖ Leise Instrumente z.B. akkustische Gitarre, Ukulele
- ❖ Handarbeitmaterial z.B. Strickzeug
- ❖ Material zum Basteln/Zeichnen



Schedule Neutral Condition



Schedule Hunger Condition



Schedule Social Isolation

