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"The effects of social closeness on approach/avoidance responses towards social and non-social stimuli "

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Abstract

Studies suggest that oxytocin modulates the neural circuits crucial for the approach and avoidance behavior regulation. While oxytocin has traditionally been related mostly to specific social behaviors, Harari-Dahan and Bernstein claim that oxytocin increases the approach behavior towards positive and decreases the avoidance behavior towards negative social and non-social stimuli, as long as they are emotionally and personally highly relevant. Furthermore, the presence of socially close individuals in a stressful situation has been repeatedly shown to decrease stress-responses and withdrawal behaviors both in animals and humans, which is named *social buffering*. It has been found that oxytocin is an important or even necessary mediator of the social buffering effect. The presence of a socially close person in a stressful situation facilitates oxytocinergic mechanisms in several brain areas, including the areas that regulate approach/avoidance motivation. Therefore, it is likely that similar mechanisms are triggered by the presence of socially close persons and modulate approach/avoidance behavior. The aim of this thesis was to test whether being accompanied by socially close persons increases the approach towards positive and decreases the avoidance towards negative social and non-social stimuli.

In order to address this topic, an experiment was conducted on 59 female subjects. Social closeness was experimentally induced in groups of four by creating a sense of similarity with other participants in the room. In the control group, a sense of dissimilarity with other participants was induced. A self-report scale of affiliation and inter-personal closeness was administered after the induction, in order to check the effectiveness of the experimental manipulation. Approach/avoidance behavior was measured two times, before and after the social closeness induction, by having the participants perform an approach/avoidance task. This task consisted of spontaneously increasing or decreasing the size of the presented pictures using the UP and DOWN keys on a keyboard, thus indicating approach or avoidance responses. Participants were presented with 120 stimuli in total, belonging to 6 stimulus categories: 2 (social/non-social) x 3 (positive/neutral/negative). Social and non-social images were matched for arousal and valence ratings separately for positive, neutral and negative stimuli. In order to monitor positive and negative affective states during the experiment, a commonly used self-report affect scale was administered after each run of the approach/avoidance task. Additionally, two questionnaires assessing personality traits were administered: the anxiety sensitivity index (ASI) and the behavioral inhibition/activation system (BIS/BAS) questionnaire. At the end of the experiment, participants were asked about their experiences of the tasks through several previously prepared questions.

It was expected that the similarity condition would increase the number and speed of approach responses to social and non-social positive stimuli and decrease the number and speed of avoidance responses towards social and non-social negative stimuli, as compared to the dissimilarity condition. It was also expected that the effect on avoidance of the negative stimuli would be stronger for participants with higher anxiety sensitivity and BIS scores and that the effect of approach to positive stimuli would be stronger for the participants with higher BAS score. Data were analyzed using several mixed model analyses of variance for testing the effects of experimental manipulation on social approach, social avoidance, non-social approach and non-social avoidance. In addition, the same analyses were performed selectively on participants with higher scores on the personal traits. Finally, exploratory analyses focused on additional effects of experimental manipulation, and the link between trait measures and approach/avoidance behavior.

Our results indicate that social closeness did not increase the approach behavior towards positive stimuli, nor decreased the avoidance behavior towards negative stimuli, thus the main hypotheses were not confirmed. The expected social closeness effects on avoidance behavior were also not found in participants with high anxiety sensitivity, and the effects on approach behavior were also not found in participants with high BAS. Participants with high BIS who went through social closeness induction showed no change in the avoidance behavior towards negative non-social stimuli. However, given that an increase of avoidance behavior towards non-social negative stimuli was found both in the dissimilarity group high on BIS and the entire sample, the direction of this trend was consistent with the expectation that social closeness would inhibit avoidance behavior. Unexpectedly, the similarity group with high BIS showed an increase in the size of non-social positive stimuli, which was rather expected in participants high on BAS.

In sum, the hypotheses of this study were not confirmed, but the results imply that the expected effects of social closeness on approach and avoidance behavior towards non-social stimuli might exist in participants with high BIS. Given that this is the first study that tried to directly show the effects of social closeness on approach and avoidance behavior, it provides several methodological and theoretical insights that are valuable for future work on the topic.

Es wurde festgestellt, dass Oxytocin ein wichtiger Mediator des sozialen Puffer-Effektes, einer Stressreduktion, die durch die Anwesenheit von sozial nahen Individuen hervorgerufen wird, ist. Auch wurde angenommen, dass oxytocinerge Mechanismen, welche diesen Effekt vermitteln, das Annäherungsverhalten gegenüber positiven Stimuli erhöhen und das Vermeidungsverhalten gegenüber negativen Stimuli verringern, dies sowohl bei sozialen als auch bei nicht-sozialen Stimuli. Das Ziel dieser Masterarbeit war es, zu testen, ob die Begleitung durch sozial nahestehende Personen das Annäherungsverhalten und Vermeidungsverhalten erhöht bzw. verringert, sowohl gegenüber sozialen als auch nicht-sozialen Stimuli. Um dies zu testen, haben wir soziale Nähe experimentell herbeigeführt, indem wir unter den Teilnehmern in kleinen Gruppen ein Gefühl der Ähnlichkeit, im Gegensatz zu einem Gefühl der Unähnlichkeit, manipuliert haben. Das Annäherungs- / Vermeidungsverhalten wurde vor und nach der Induktion der sozialen Nähe durch eine Aufgabe gemessen, bei der die Teilnehmer spontan die Größe der Bilder aus 6 Kategorien — 2 (sozial / nichtsozial) x 3 (positiv / neutral / negativ) — durch Drücken bestimmter Tasten vergrößerten oder verkleinern konnten, womit sie die Annäherungs- bzw. Vermeidungsreaktionen signalisierten. Wir erwarteten, dass die Induktion der sozialen Nähe die Anzahl der Annäherungsreaktionen auf positive Stimuli erhöhen und die Anzahl der Vermeidungsreaktionen auf negative Stimuli verringern würde, sowohl auf sozialer als auch auf nicht sozialer Ebene. Die Ergebnisse der gesamten Stichprobe bestätigten diese Hypothese nicht. Bei Teilnehmern mit höherer Sensitivität gegenüber unangenehmen Stimuli, die mittels des Inventars der Verhaltenshemmsysteme gemessen wurde, induzierte die soziale Nähe jedoch eine Zunahme der Annäherung an nicht-soziale positive Stimuli und zeigte einen Trend zur Hemmung der Vermeidung von nicht-sozialen negativen Stimuli. Dies war eine erste Studie, die die Auswirkungen von sozialer Nähe auf das Annäherungs- / Vermeidungsverhalten untersuchte und obwohl die Ergebnisse nicht schlüssig sind, liefert sie viele Einsichten für zukünftige Forschung zu diesem Thema.

1 Introduction

"...the presence of others calls forth a basic and implicit interaction that shapes the way that we regard the world around us" (Gallagher, 2009, p. 15)

The presence of other people changes the way we respond to the environment in many different ways, which has been acknowledged by philosophers (e.g. Gallagher, 2009) and psychologists (e.g. Zajonc, 1965). In my master thesis, I examined how the presence of socially close persons, as opposed to the presence of not socially close persons, modulates a basic behavioral tendency to approach positive emotional pictures and to avoid negative emotional pictures, with either social or non-social content.

The distinction between approach and avoidance is the most basic motivational and behavioral distinction in all living organisms, including humans. Although it refers to some basic behavioral reactions to stimuli in the animal world, such as running away from predators (avoidance) or approaching the partner during the mating season (approach), many behaviors that humans perform are underpinned by similar approach/avoidance processing mechanisms. While approach motivation orients the organism to thriving and exploring novel stimuli, avoidance motivation orients it towards survival and avoidance of the factors that put it into danger. One can approach both non-social stimuli (such as a delicious plate of food) and social stimuli (e.g. a supportive hug from a friend), and one can also avoid unpleasant non-social stimuli (e.g. a two weeks old fruit) or social stimuli (e.g. a neighbor yelling at us on the street). Some studies reviewed in the next chapter suggest that the brain mechanisms that determine whether we want to approach or avoid certain relevant stimuli are fundamentally similar in case of social and non-social stimuli (Ruff & Fehr, 2014). This idea suggests that there is a general approach/avoidance system in the brain, which is concerned with the evaluation and preparation of the adequate behavioral programs towards all stimuli that are emotionally evocative and salient, irrespective of their social or non-social connotation (Harari-Dahan & Bernstein, 2014).

How do these approach/avoidance circuits determine whether something is relevant and whether something should be approached or avoided? The answer to this question is very complex and there are many chemical mechanisms that contribute to the processing of relevant stimuli from the environment (Harmon-Jones, 2011). One neuropeptide that has been recently suggested as a modulator of approach and avoidance motivation is oxytocin. Usually referred to as a 'social neuropeptide', oxytocin has many social functions both in animals and humans, such as promoting the establishment of social bonds between mother and child, facilitating social memory, but also reducing stress and fear (Campbell, 2010; Love, 2014). However, it has been recently suggested by a new theory of oxytocin, that it might also have the general

role of facilitating approach-related emotions and behaviors and inhibiting avoidance-related emotions and behaviors towards motivationally relevant stimuli (Harari-Dahan & Bernstein, 2014).

Importantly, the release of oxytocin in the brain is increased when one is accompanied by or interacts with a socially close person (Kikusui, Winslow, & Mori, 2006). Oxytocin has been repeatedly identified as one of the main mediatory mechanisms underlying the impact that the presence of close people has on the reduction of stress-responses and withdrawal behavior. Some of the key structures included in the regulation of the approach/avoidance behavior are rich in oxytocin-binding receptors and they were also proposed to have a role in the stress-buffering effect of social closeness (Kikusui et al., 2006).

Integrating these different insights from the social neuroscience literature instigated the idea that feeling connected, familiar and close to other people could, possibly via the proposed oxytocinergic mechanisms, facilitate the tendency to approach positive and novel stimuli in the environment and inhibit the tendency to avoid negative and fear-inducing stimuli in the environment. This is exactly the question this thesis aims to address. Given the contrasting accounts on whether oxytocin affects approach/avoidance only towards social stimuli or towards non-social stimuli as well, both types of stimuli were included in this study.

This thesis is divided into several parts that correspond to the different phases of the research process. In Chapter 2, the theoretical background is introduced, starting with a definition of two core concepts: approach/avoidance motivation and motivational relevance of stimuli. The first main background topic is the social buffering effect, which is presented with a special focus on the importance of the familiarity of the buffering partner. Neural studies of social buffing are then reviewed, especially the most researched mediatory role of oxytocin. Another key background topic is the role of oxytocin in affecting approach/avoidance behavior. The main theories and findings from both social and non-social contexts are listed. At the end of this section, our current knowledge about the basic approach/avoidance circuits is presented, especially focusing on the roles oxytocin may play in these circuits. These topics constitute the theoretical background of this thesis. After this, Chapter 3 'Present study' follows, in which different lines of research stated in the theoretical background are connected, bringing about the research questions and the hypotheses of this thesis. Next, interdisciplinary aspects and the novelty of this work are discussed in Chapter 4. The methodological paradigms and the procedures of the experiment are then described in Chapter 5, and the results of the study are presented in Chapter 6. Chapter 7 includes a discussion of the found effects, a commentary on the methodological limitations of the study, theoretical considerations, and implications for future work.

2 Theoretical background

2.1 Approach/avoidance motivation and motivational relevance

Approach motivation is defined by Elliot (2008) as "energization of behavior by, or the direction of behavior toward, positive stimuli (objects, events, possibilities)", and avoidance motivation "as the energization of behavior by, or the direction of behavior away from negative stimuli (objects, events, possibilities)" (Elliot, 2008, p. 3). The core concepts of this definition are: (1) *positive/negative evaluation of stimuli*, (2) *energization and direction of behavior* and (3) *movement* (physical or psychological) in relation to stimuli. Here stimuli can be understood in the broadest sense, as objects, events or possibilities, which can either be observed or abstract (mentally represented) (Elliot, 2008). According to this definition, automatic evaluation of a stimulus as positive/beneficial/pleasant initiates preparedness for approach-oriented movement, while automatic evaluation of a stimulus as negative/harmful/unpleasant energizes preparedness for avoidance-oriented movement. The approach/avoidance distinction is contained in the very basis of the motivation of all living organisms, with the ultimate goal to produce adaptive behavior, which promotes survival and thriving. There are certain exceptions to the idea of a one-to-one relation between affective valence and approach/avoidance, as approach motivation can also be related to negative affect, for example, anger and aggressive behavior (an approach behavior) (e.g. Kemp & Guastella, 2011).

The broad concept of approach/avoidance motivation comprises many mechanisms on different levels of conceptualization – from physiological to cognitive. Eder et al. (2013) tried to differentiate two main levels of analysis of approach/avoidance behavior: *the reflex-oriented view* and *the action-oriented view* (Eder, Elliot, & Harmon-Jones, 2013). The reflex-oriented level of analysis is concerned with the automatic evaluative *reaction* to stimuli which directly leads to behavioral preparedness (Lang & Bradley, 2010), and the action-oriented level of analysis is concerned with deliberate action preparedness, based on the hierarchically higher concept of goals (Elliot, 2006). In humans, different approach/avoidance mechanisms are at play at the same time, giving different inputs that influence the final behavior– both the automatic evaluation of stimuli and their interaction with different higher mental representations. For example, when one sees a delicious cake, one might have an automatic tendency to approach it, but also to avoid it, based on a deliberate decision to take a diet.

Another concept intertwined with approach/avoidance motivation is *motivational relevance* or *salience* of stimuli. Cunningham and Brosch define motivational relevance as "usefulness for any momentary motivational state of the individual" (Cunningham & Brosch, 2012, p. 56), motivational states being regulated by different appetitive (approach) and aversive (avoidance) motivational circuits. Motivational relevance ideally represents the importance of a stimulus for survival and maintenance of

well-being. A relevant stimulus in the environment automatically recruits attentional resources (*orienting response*), as well as preparedness for the adequate action (Eitam & Higgins, 2010).

Regarding the neural basis of approach/avoidance motivation and motivational relevance, authors usually refer to basic motivational circuits (Lang & Bradley, 2010) or survival circuits (LeDoux, 2012). These brain networks regulate appetitive and aversive motivational processes, both by recruiting attention in an encounter with a relevant stimulus and by generating preparedness for adequate approach or avoidance behavior. According to Lang and Bradley, automatic evaluation of stimulus *valence* (positive or negative) is decisive to whether the appetitive or aversive motivational system will be dominantly activated, while *arousal*, i.e. the intensity of activation, corresponds to the motivational relevance of the stimulus (Bradley, 2009; Lang & Bradley, 2010).

Often, the circuits that underlie appetitive and aversive motivation are also responsible for signaling the motivational relevance of the stimulus. The amygdala is important both for regulation of autonomic and behavioral responses to threat (e.g. freezing) (Cain & LeDoux, 2008), and determination of emotional relevance of stimuli, primarily by regulating general arousal (Cunningham & Brosch, 2012; Harmon-Jones, 2011; LeDoux, 2012). The connectivity between the prefrontal cortex and the amygdala has also been shown to be important for motivational relevance processing (Cunningham, Van Bavel, & Johnsen, 2008). Furthermore, the mesolimbic 'reward' system plays an important role in appetitive and aversive processes, as well as in coding of motivational relevance. According to the *incentive salience theory*, the dopaminergic system in the nucleus accumbens (NAc) regulates the 'wanting' aspect of the reward (Berridge, Robinson, & Aldridge, 2009). The incentive salience of reward translates to the level of effort one is ready to deploy in order to obtain the reward, and in that sense, this system is important for energizing the approach behavior. Additionally, studies show that caudal parts of NAc encode prediction errors of negative stimuli, showing that the NAc is also involved in aversive and not only appetitive processes (Reynolds & Berridge, 2002). While the anterior NAc is involved in the appetitive motivation, i.e. reward processing, the posterior NAc is involved in the avoidance motivation, i.e. threat processing (Seymour, Daw, Dayan, Singer, & Dolan, 2007).

Several other key brain areas related to approach/avoidance motivation and motivational relevance should also be mentioned. Research on the experience of reward and punishment shows that the medial orbitofrontal cortex (OFC) is activated while experiencing a reward, while the lateral parts of OFC are more related to experiencing punishment (Harmon-Jones, 2011). Experience of punishment and especially pain is also related to activation of the anterior insula and anterior cingulate cortex, while the signals in the ventromedial PFC have been shown to encode the subjective value of a stimulus, important to comparative valuation of different options during decision making (Lin, Adolphs, & Rangel, 2011; Ruff & Fehr, 2014). Frontal asymmetry is also related to approach and avoidance motivation, as the left frontal symmetry has

repeatedly been connected to approach motivation and positive affect, and the right frontal asymmetry to withdrawal and negative affect (Harmon-Jones, 2011).

Altogether, an extensive set of brain circuits are involved in approach/avoidance motivation, as well as in determining motivational relevance. These circuits work together to produce readiness for the most adaptive behavior in a certain moment, given the information about the stimulus and its context. While motivational relevance is more related to the intensity of motivation, it cannot be determined without the evaluation of the stimulus as positive/negative, which automatically translates to a readiness to approach or withdraw (which might or might not be actualized).

2.2 Social buffering, social closeness, and neural mechanisms

It has been shown in different social species that the presence of a conspecific in a stressful or a challenging situation reduces stress responses and facilitates recovery from the aversive effects of stressors. This effect is called *social buffering* (Davitz & Mason, 1955; also see Kiyokawa, Honda, Takeuchi, & Mori, 2014). In the original experiment (Davitz & Mason, 1955), fear-conditioned rats were presented with a conditioned stimulus in a novel environment, which resulted in withdrawal behavior. The rats that were accompanied by another, non-fearful, rat showed a decreased withdrawal response. In this study, the effect on the stress-related behavioral response was measured, but most of the later studies focused on the effect of the accompanying conspecific on the physiological stress-responses. The primary stress-response universally probed in social buffering studies is the activity of *hypothalamic-pituitary-adrenocortical (HPA) axis*, and the most commonly used measures of this activity are levels of cortisol in blood, saliva or urine, but also more direct measures, such as levels of ACTH hormone or norepinephrine (Hennessy, Kaiser, & Sachser, 2009; Kiyokawa & Hennessy, 2017). This is why the social buffering effect is often identified with the reduction of HPA activity in the presence of the partner.

2.2.1 Social closeness and social buffering

Sometimes the presence of another conspecific can also be a stressor and does not necessarily lead to social buffering effects (Kikusui, Winslow, & Mori, 2006). For instance, prairie voles that previously went through a pair-bonding process showed high levels of aggression in the presence of unfamiliar conspecifics (Aragona & Wang, 2009). The main factor enabling social buffering to occur is the *familiarity* or *social closeness* of a partner (Kikusui et al., 2006; Hennessy et al., 2009). Attachment relationships, such as to the mother (Mason & Capitanio, 1988), father (Hoffman, Mendoza, Hennessy, & Mason, 1995), or a long-term partner (Smith & Wang, 2014) have all been shown to be successful in eliciting social buffering effect in different species. However, even weakly familiar conspecifics could be more efficient in reducing the HPA activity of their buffering partners, compared to unknown conspecifics, as shown in monkeys

(Coe, Franklin, Smith, & Levine, 1982) and rats (Kiyokawa, et al., 2014). When it comes to social buffering by unfamiliar conspecifics, there are opposing findings (Kiyokawa & Hennessy, 2017) which seem to vastly differ depending on the species characteristics, the age of subjects, and experimental setting.

A recent study systematically compared social buffering effects in the presence of familiar and the unfamiliar rats (Kiyokawa, et al., 2014). When fear-conditioned rats were put in a room previously scented by the smell of a familiar rat (in the control group it was scented by the smell of an unfamiliar rat), freezing behavior following the presentation of CS decreased, as well as the Fos expression (the number of immune-reactive cells) in the PVN and the lateral amygdala (LA). The Fos expression in PVN and LA was decreased both by the scent of familiar and unfamiliar conspecifics; nevertheless, the effects were significantly higher in the familiar condition.

There are fewer studies experimentally investigating the effects of social closeness on social buffering in humans. Most of them compare the effectiveness of family and peer members as social buffering partners. Gunnar and Hostinar (2015) focused on the role of different social buffering partners throughout the human development in their review paper, showing the dominant roles of parents during childhood, of friends during adolescence, and romantic partners in adulthood (Gunnar & Hostinar, 2015). Furthermore, there is evidence of gender differences in stress buffering in adults. While in men, the presence of the romantic partner led to reduced activation of HPA axis, this was not the case in females (Kirschbaum, Klauer, Filipp, & Hellhammer, 1995). On the other hand, females showed a decreased reaction to social stressors in presence of other females, both familiar or unfamiliar (Fontana, Diegnan, Villeneuve, & Lepore, 1999). To my knowledge, no studies up to this date examined social buffering effects in humans using the laboratory induction of social closeness between previously unknown individuals. In a study on a related topic, however, experimentally induced social closeness reduced self-reported stress response during a tape stripping procedure of the skin and also improved skin barrier-recovery (Robinson, et al., 2017).

2.2.2 Neural mechanisms of social buffering

Studies addressing the neural mechanisms behind the social buffering effect commonly point at **oxytocin (OT)**. OT is a neuropeptide produced in the PVN and the supra-optic nuclei of the hypothalamus, spreading to the blood flow and numerous areas of the brain. It is traditionally known to be involved in the regulation of lactation and parturition (e.g. Yang, Wang, Han, & Wang, 2013), but it is also known for its anxiolytic effects (e.g. Heinrichs, Dawans, & Domes, 2009). The release of OT in several brain regions, including the PVN and the amygdala, is related to the reduction of the HPA axis activity in stressful conditions (Windle, Shanks, Lightman, & Ingram, 1997; Neumann, 2002). A genetic study showed that OT decreases stress-induced cFos mRNA expression in various forebrain regions involved in the regulation of the HPA axis, such as the PVN and the medial amygdala (Windle et al., 2004).

Apart from its calming effects on the HPA axis, OT has also been repeatedly shown to decrease expression of defense-related withdrawal behaviors. Smith and Wang (2014) showed the mediating role of oxytocin in social buffering in prairie-voles. In this study, reduction of anxiety-like withdrawal behaviors and corticosterone levels in the presence of a partner was accompanied by an increased release of OT in the PVN (Smith & Wang, 2014). Moreover, if an OT antagonist was injected in PVN, the social buffering effect was blocked. Ebner et al. showed that the release of OT in the central amygdala is responsible for the reduction of behavioral stress-response through the inhibition of excitatory neuropeptides in the central amygdala (glutamate and aspartate) (Ebner, Bosch, Krömer, Singewald, & Neumann, 2005).

Heinrichs et al. (Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003) showed that OT enhances the stress-reducing effects of social support in humans. In an induced stressful situation, the presence of a supportive friend and OT administration had similar effects on physiological (cortisol levels) and self-report measures of stress. While both the presence of a friend and OT administration had anxiolytic effects on their own, the stress-reducing effects were strongly facilitated when both of these factors were present. The authors suggested that the more OT is available in the central nervous system, the more effective the interaction with a familiar partner is in terms of social buffering. Furthermore, a neurogenetics study (Chen, et al., 2011), which used the same stress-induction and social support techniques as Heinrichs et al, showed that the effectiveness of social support to produce social buffering depends on a single nucleotide polymorphism (rs53576) on the oxytocin receptor gene. Whether the presence of a friend is effective for one's stress reduction (measured by cortisol levels and self-reports of stress), depended on having one or two copies G allele on rs53576 (and not A allele) on the same nucleotide. From different angles, these three studies speak in favor of a mediatory role of OT in social buffering in humans.

Another study performed in 12-year-old children used a similar stress-induction method as the previous two. They showed that release of oxytocin was increased in the condition in which the mothers were present and in the condition in which the children talked with their mother on the phone before the task, but not in conditions in which children only texted their mothers before the task or in which there was no contact with mothers at all (Seltzer, Prososki, Ziegler, & Pollak, 2012). Increased release of oxytocin was related to a higher stress-reduction effect. The authors concluded that having a conversation or merely hearing the voice of a close person is important for the social buffering effect to occur, but importantly, their results also suggest the involvement of oxytocin in this effect.

In the above-mentioned human studies of the mediatory role of oxytocin in social buffering, the buffering partners were family or friends. There are no similar studies using laboratory induction of social closeness instead of real-life relationships. However, there are some related findings relevant to this issue. A study by Brown et al. (2009) included "the social closeness task", an experimental method for inducing social closeness, and showed that the induction leads to an increase in levels of hormone *progesterone*

(Brown, et al., 2009). Progesterone release is closely related to OT release, and it even may serve as an index for increased OT release in the hypothalamus (Bale, Pedersen, & Dorsa, 1995; Schultheiss, Wirth, & Stanton, 2004).

The reviewed literature indicates that OT modulates the stress response through its attenuating effects on the HPA axis, but also that it decreases anxiety-related behavioral responses, such as withdrawal behaviors, possibly through the inhibitory effects in the amygdala. Kikusui, Winslow, and Mori (2006) propose a neurobiological model of OT action, which includes several brain structures, including the hypothalamus and the amygdala. According to the model, OT levels in the amygdala increase in response to social buffering cues (e.g. visual and auditory cues signaling the presence of a close person). Oxytocin then modulates the signals sent from the amygdala to the brain stem, the NAc (where the OT also modulates the opioidergic activity), and the hypothalamus, modulating both behavioral and stress-endocrine responses to stressors. If the presence of an affiliated person can increase the levels of OT circulating in the brain, as has been suggested, the abovementioned circuits may contribute to the effects of OT on stress- and behavioral responses.

Finally, apart from the prevailing role of oxytocin, the above-mentioned social buffering model of Kikusui et al. also addresses the role of endogenous **opioids** in the hypothalamus. Endogenous opioids have an important role in establishing close relationships and affiliation (Panksepp, Herman, Conner, Bishop, & Scott, 1978). Opioids in the NAc are released in response to positive social stimuli, and their release has a rewarding effect (Machin & Dunbar, 2011). This pleasant, rewarding effect of social contact is considered to be the basis for establishing social closeness, which is important for social buffering to occur. Kikusui et al. offer two sources of evidence that interaction between opioids and oxytocin is necessary for the social buffering effect. Firstly, OT was reported to stimulate the release of opioids and increase dopamine transmission in the reward pathway (Uvnäs-Moberg, 1998; Young & Wang, 2004; Depue & Morrone-Strupinsky, 2005). Secondly, an opioid antagonist has been shown to block the inhibiting effects of oxytocin on HPA axis, pointing to the importance of opioid-oxytocin interaction (Douglas & Russell, 2001).

Another group of authors has shown that oxytocin does not always have a stress-reducing effect, but that it can also lead to increase of distress and anger, especially if the social context is negative. According to Olff et al (2013), among other factors, the nature of the social context (positive and supporting vs. negative and threatening) determines which direction the effects of oxytocin would take (Olff, et al., 2013). One study showed that administration of oxytocin prior to a coordination game, either with a stranger or with a familiar person, affected the level of cooperation (Declerck, Boone, & Kiyonari, 2010). In comparison to the placebo group, OT led to a decrease of cooperation if one played with strangers, and to an increase in cooperation if one played with familiar people. Further, Kubzansky et al. (2012) conducted

a study in which participants went through social stress accompanied either with a friend, a supportive stranger, or were alone, and either received a dose of OT, or placebo (Olff, et al., 2013). The results showed that the stranger increased negative affect and stress response in comparison to the familiar person and that OT additionally exacerbated this effect. In another study, the same group of authors suggested that OT stimulates an *approach-oriented cardiovascular profile* during stressful situations, which can have both positive and negative implications (Kubzansky, Mendes, Appleton, Block, & Adler, 2012). A general atmosphere of social context (either positive or negative) determines whether the effects of oxytocin will go more in a direction positive approach emotions and fear reduction, or towards increased negative approach emotions, such as anger. Thus, they claimed that the emotional social context (regardless of valence) increases a physiological readiness to engage through OT mechanisms.

2.3 Oxytocin and approach/avoidance motivation

In the previous section, it was mentioned that oxytocin might increase biological approach readiness, or elicit an *approach cardiovascular profile* (Kubzansky et al., 2012). This opens another topic relevant for this study - the link between oxytocin and approach/avoidance motivation. As will be discussed, several authors have stated that oxytocin is likely to facilitate various approach-related responses and attenuate avoidance-related responses (Cohen, et al., 2017; Kemp & Guastella, 2011; Harari-Dahan & Bernstein, 2014). Most of the evidence for this hypothesis has been found in the framework of social motivation and focused only on social effects of oxytocin. Some studies also tried to explicitly show that oxytocin affects behavior only in relation to social stimuli, and not non-social stimuli (e.g. Baumgartner, Heinrichs, Vonlanthen, Fischbacher, & Fehr, 2008; Norman, et al., 2011). However, other studies found oxytocin effects in relation to non-social contexts, e.g. facilitation of learning and memory, regulation of pain perception, etc. (see Yang et al., 2013). The chapter will be concluded by presenting the *general approach/avoidance hypothesis of oxytocin* (GAAO) by Harari-Dahan and Bernstein (2014), which argues for general effects of oxytocin in the circuits underlying the approach/avoidance processes both towards social and non-social stimuli, as long as these are emotionally evocative and personally relevant (Harari-Dahan & Bernstein, 2014).

2.3.1 Evidence from social contexts

Oxytocin has been researched in both animals and humans mostly in the context of its positive effects on social behavior, which is referred to as *the prosocial hypothesis of OT* (Kemp & Guastella, 2011). As shown in animal studies, OT has a prosocial function during the lactation period and childbirth, and oxytocinergic mechanisms seem to be crucial for the development of social bonding and affiliation (Love, 2014; Heinrichs et al., 2009). In humans, OT has been shown to facilitate social behaviors such as empathy,

trust, emotion recognition, social perception and social memory (Bartz, Zaki, Bolger, & Ochsner, 2011; Ross & Young, 2009). However, recently the studies started to show not only positive but also "negative" social effects of oxytocin (Shamay-Tsoory, et al., 2009; Olff, et al., 2013; Declerck et al., 2010). Contextual cues (e.g. the presence of a familiar person), as well as interpersonal variables (e.g. mental disorders), seem to determine whether OT will have positive, negative, or no effects on behavior (Bartz et al., 2011; Olff, et al., 2013). Shamay-Tsoory et al. (2009) showed that OT increased negative feelings of envy and gloating towards the opponent if the social context was competitive. In the same study, Shamay-Tsoory et al. introduce *the social salience hypothesis of OT* (Shamay-Tsoory, et al., 2009).

According to the social salience hypothesis, OT regulates attention-orienting responses towards social cues through its interaction with the dopaminergic system (Shamay-Tsoory & Abu-Akel, 2016). The salience or relevance of a stimulus is assigned by dopamine signals in the VTA and further processed by the NAc and the amygdala. OT acts on the dopaminergic system (VTA and NAc) and increases the salience of relevant social cues, irrespective of valence, by boosting the dopaminergic salience-coding signals. OT has no effects if the social environment is rather neutral and irrelevant. Furthermore, the VTA and the amygdala facilitate attentional responses to relevant social cues through their effects on the superior colliculi (brain stem structures related to attention). An important implication of this hypothesis is that OT can increase the salience of both safety signals and threatening signals, depending on the social context. In a positive and salient social context, it can increase stress-response and facilitate pro-social behavior, but in a negative and salient social context, it can increase stress and aggressive behavior. Moreover, Shamay-Tsoory and Abu-Akel claim that the effects of oxytocin are social-specific, directed exclusively to other humans and referring only to social contexts. They list evidence supporting the social specificity of the attentional effects (Rimmele, Hediger, Heinrichs, & Klaver, 2009; Norman et al., 2011).

Kemp and Guastella have offered an alternative explanation for the findings of Shamay-Tsoory et al. on envy- and gloating-inducing effects of OT (Kemp & Guastella, 2010). They claimed that rather than the salience of the competitive social context, the reason why oxytocin facilitated gloating and envy is that these two emotions are related to approach motivation. The authors presented their own account of the social effects of OT – *the social approach/avoidance hypothesis of OT* (Kemp & Guastella, 2011). According to this hypothesis, OT has a tendency to facilitate approach-related emotions and behaviors towards other people, which can be both positive and negative, and to decrease avoidance-related social emotions and behaviors. This differentiation is supported by different theories and findings. Barret and Wager analyzed different brain motivational models and argued that the approach/avoidance distinction brings us closer to understanding how brains process emotion, compared to the motivational system based on positive/negative valence and arousal (Barret & Wager, 2006). For example, Carver & Harmon Jones

have shown that left frontal asymmetry is related to positive emotions but also anger¹, which are both approach-related emotions, while right frontal asymmetry is related only to withdrawal-related emotions, such as anxiety and fear (Carver & Harmon-Jones, 2009). Furthermore, studies have shown that OT modulates the activity of the amygdala differently depending on the affective content of the observed stimuli (e.g. Kirsch et al, 2005; Gamer, Zurowski, & Büchel, 2010). For example, Gamer et al. showed that nasally administered OT dampened the activation of the left amygdala in response to fearful faces (avoidance-related), and facilitated the activation of this region in response to happy faces (approach-related) (Gamer et al., 2010). According to Kemp and Guastella, the amygdala findings are not in line with the social salience hypothesis, as it would predict that activity of the amygdala in a salient negative situation will be further facilitated by OT, and not inhibited.

Aside from the above-mentioned theories, there is a lot of evidence directly showing the effects of OT on social approach/avoidance behaviors, both in animals and humans. When it comes to the animal studies, several studies in rats or mice (Lukas, et al., 2011; Arakawa, Arakawa, & Deak, 2010), and other animals (e.g. Insel & Shapiro, 1992) show such effects. For example, Lukas et al. have shown in rats and mice that an OT receptor antagonist reduced approach to novel con-specifics and increased avoidance behavior, while the effect was reversed when an oxytocin agonist was administered (Lukas, et al., 2011). The first study to use an approach/avoidance experimental paradigm, i.e. an approach/avoidance task (AAT) in addressing the effect of OT on approach/avoidance behavior in humans gave unclear results, as OT only increased the speed of reaction, both in case of social approach and social avoidance (Theodoridou, Penton-Voak, & Rowe, 2013). In contrast. Radke et al., who used a similar AAT, showed that OT increased approach to angry faces with a direct gaze, but not to angry faces with averted gaze (Radke, Roelofs, & De Bruijn, 2013). These results were interpreted from the stance of the social salience hypothesis (direct gaze being more salient than averted gaze), however, they are also in line with the social approach/withdrawal hypothesis. Interestingly, Cohen and Shamay-Tsoory showed that OT administration increased active social approach of a protagonist in virtual space, showing stronger effects on social approach when protagonists were strangers, compared to friends (Cohen, et al., 2017). The authors interpreted this outcome in line with the social salience and anxiety reduction hypothesis of OT, but it is also consistent with the social approach/avoidance hypothesis.

¹ The common finding that angry faces stimulate withdrawal responses equally as fearful faces (e.g. Gamer, Zurowski, & Büchel, 2010). Kemp and Guastella explain it by the difference between experiencing anger and perceiving it - the latter rather induces fear and not anger (Kemp & Guastella, 2011). However, there are also studies in which perceived angry face induced approach behavior in an experimental approach/avoidance task (Radke et al., 2013)

2.3.2 Evidence from non-social contexts

The tradition of oxytocin research is closely related to its social functions, however, there are also studies trying to explicitly show that oxytocin does not affect non-social aspects of behavior - only social aspects. There are several studies reviewed by Harari-Dahan and Bernstein comparing the effects of OT on affective ratings (Cardoso, Ellenbogen, & Linnen, 2014) and learning and recognition (Hurlemann, et al., 2010; Rimmele et al., 2009) of social and non-social stimuli. These studies showed that OT facilitated learning and memory only for social stimuli, and increased arousal ratings only for social stimuli and not non-social. Harari-Dahan and Bernstein draw attention to the limitation common to these studies. While social stimuli (e.g. smiling and fearful faces, words related to romantic relationships, etc.) were clearly personally relevant and emotionally evocative in these studies, non-social stimuli were not as relevant nor emotional (e.g. green and red lights, photos of nature, words that explain feelings, rather than induce them). Another study not included in their review compared OT effects on arousal ratings of threatening human (social) and animal (non-social) pictures previously matched for valence and arousal (Norman et al., 2011). The results showed that only arousal ratings of human pictures were decreased by OT, and not of animal pictures. However, one could also argue that both human and animal pictures were, in fact, social, but that the personal relevance of the human threatening pictures was higher compared to the animal threatening pictures. Furthermore, Baumgartner et al. showed that OT increased risk-taking behavior in a social trust game, but did not affect risk-taking behavior in a similar non-social task (Baumgartner et al., 2008). Although none of these studies directly compared approach/avoidance behavior towards social and nonsocial stimuli, they offer relevant arguments for the socially specific effects of OT on the related behaviors.

To argue against the conclusions drawn from these studies, Harari-Dahan and Bernstein review several findings showing OT effects on non-social behavior. First, there are many studies done on mice and rats, showing that OT decreases anxiety- and fear-related behavior in various non-social situations stressful for rats (e.g. open field test or forced swimming test) (Onaka, Takayanagi, & Yoshida, 2012; Yoshida, et al., 2009; Windle et al., 1997; Neumann, 2002). In one of the studies, OT was administered directly in the amygdala, resulting in decreased anxiety-related behavior in mice, which also points to the potential neurobiological mechanisms of the effect (Ebner et al., 2005). Furthermore, in-vivo stimulation of OT release in the central amygdala has been shown to decrease freezing (avoidance-related) behavior in fear-conditioned rats (Knobloch et al., 2012; Viviani, 2011). Importantly, an imaging study shows that OT inhibits amygdala activation during observation of non-social fearful stimuli, as well as the connectivity between the amygdala and the brain stem (the periaqueductal grey and reticular formation), the connection important for arousing the body and preparing defensive behavior programs (Kirsch, et al., 2005). Finally, OT is involved in the regulation of nociception and analgesia, it decreases addiction symptoms to some drugs, and has even been proposed to regulate the fitness of the organism as a whole (Yang, Wang, Han, &

Wang, 2013). Oxytocin evidently has many effects that are not exclusively related to social functions. This was the basis of the development of a more inclusive and general hypothesis of oxytocin, which will now be reviewed.

2.3.3 A General Approach/avoidance Hypothesis of Oxytocin (GAAO)

The basic claim of the GAAO is that OT facilitates approach and attenuates avoidance behavior towards both social and non-social stimuli, as long as they are personally relevant and emotionally evocative, i.e. salient (Harari-Dahan & Bernstein, 2014). This hypothesis is in some aspects similar to both the social salience hypothesis and the social approach/avoidance hypothesis. Just like the social salience hypothesis, it claims that OT enhances the salience of only certain stimuli, i.e. the ones that are already relevant for the person. Similar to the social approach/avoidance hypothesis, it claims that OT affects processing of approach/avoidance motivation. However, in contrast to these two hypotheses, the GAAO tries to show that the effects of OT are domain-general, rather than specific for the social domain, and that the GAAO is a more parsimonious way to explain the regulatory role of oxytocin in motivation towards salient stimuli. According to the authors, one of the reasons for the domination of social-specific findings and interpretations in this field is that the research of behavioral effects of OT was firstly developed from the idea that OT is a 'social hormone', and there is a very small number of studies questioning the social-specificity of the behavioral effects of OT. Most of the studies that do so are criticized by the advocates of the GAAO for not carefully matching the affective and salience dimensions of the social and non-social conditions used (e.g. Hurlemann, et al., 2010; Rimmele et al., 2009).

There are two main lines of argument supporting this hypothesis. First are the studies of OT effects in non-social contexts and with non-social stimuli, mostly done on animals (e.g. Lukas, et al., 2011), but also in humans (Kirsch, et al., 2005). These studies were reviewed in the previous sub-chapter (2.2.2.2. Evidence from non-social context). The second line of arguments is related to the shared neural substrate of both types of approach/avoidance motivation. Harrari-Dahan and Bernstein claim that "social" and "non-social" approach/avoidance motivation. Harrari-Dahan and Bernstein claim that "social" and "non-social" approach/avoidance motivation is based on the same underlying brain mechanisms. Therefore, since OT modulates motivational circuits that are not specifically sensitive to social or non-social motivation, it should be rather expected to modulate the system depending on the personal relevance and emotional evocativeness of the stimuli than on the social or non-social content of the stimuli. They name two key circuits modulated by OT that are involved in assigning salience and eliciting approach and avoidance behavior: **mesocorticolimbic 'wanting' circuitry** and **cortico-amygdala fear/threat circuitry**. These are the key networks through which OT affects approach/avoidance motivation, and also, these circuits seem to process both social and non-social threats and rewards (Fareri & Delgado, 2014; Lin et al., 2011).

This theory is mostly based on the literature review, but it was recently also directly tested (Harari-Dahan & Bernstein, 2017). Before and after administration of OT or placebo, participants completed a keypress task (Aharon, et al., 2001). In this task, 6 categories of emotional pictures were presented – each was either social or non-social, and either positive, negative or neutral in valence. Social and non-social stimuli were matched for arousal and valence ratings. The task was to spontaneously manipulate the presentation time of each stimulus, by pressing the 'up' key to increase (approach response), and the 'down' key to decrease the remaining time (avoidance response). Participants were additionally split into 2 groups according to their score on the cognitive aspect of the anxiety sensitivity. Anxiety sensitivity is a trait characterized by fear of experiencing emotions with high arousal, based on the belief that these sensations lead to death or insanity (Taylor, et al., 2007). It is divided in three sub-scales: cognitive, social and somatic concerns. The authors expected that negative arousing stimuli might be especially emotionally evocative and relevant for the people who fear the arousing sensations elicited by such stimuli. According to the GAAO, it was expected that OT would increase the number of approach responses to positive stimuli and decrease the number of avoidance responses to negative stimuli, both in case of the social and the nonsocial stimuli. Also, the effect on avoidance of negative stimuli was expected to be especially pronounced in anxiety sensitive individuals. The findings partially corresponded to the expectations - the expected effects of OT were obtained in the anxiety sensitive group for the avoidance of negative stimuli, both for the social and the non-social stimuli. However, no effects were obtained for approach behavior, and none of the effects were observed in the participants who were not anxiety sensitive. These findings are in line with the GAAO and partially with the social salience hypothesis. According to both hypotheses, OT is expected to exert its effects only with stimuli that have high chronic or situational relevance. In this case, negative arousing stimuli have chronic relevance for highly anxiety sensitive people. Crucially for the GAAO, the effects were shown for both the social and the non-social stimuli, which suggests that more studies with carefully matched levels of arousal and valence between social and non-social stimuli are needed.

2.3.4 General approach/avoidance circuits and oxytocin

Before the research question of this thesis is introduced, this chapter will be concluded by summarizing what is currently known about the general role oxytocin plays in some of the neural circuits proposed to modulate approach and avoidance behavior.

a) Approach

The midbrain dopaminergic system is known to regulate the 'wanting' aspect of reward, representing its incentive salience (Berridge et al., 2009). Dopamine signals in the striatum underlie valuation of stimuli in the appetitive or approach reward phase, in which behavior is energized towards the desired stimulus (Depue & Morrone-Strupinsky, 2005). This system is known to be activated by primary rewards, such as food, but secondary rewards, such as money, have been shown to activate the same regions

(Fareri & Delgado, 2014). Importantly, social rewards such as social attractiveness and social approval activate the same striatal structures in humans (Izuma et al., 2008; Rademacher et al., 2010, Lin et al., 2011; Saxe & Haushofer, 2008). These findings inspired the development of *the common currency hypothesis* (Ruff & Fehr, 2014). According to this hypothesis, the same type of signals in the same circuits encode the value of both social and non-social rewards. This shared system receives input from social or non-social specialized structures in higher cognitive areas, but the same neurons compute the relevance of both social and non-social stimuli. On the contrary, the hypothesis of *social-specific cognition*, inspired by *the social brain hypothesis* (Dunbar, 1998), suggests that circuits encoding the neural value of social and non-social stimuli are anatomically and functionally separate, even if they reside in shared neural regions (Adolphs, 2010).

Studies show that OT exerts its prosocial effects, at least partially, through the up-regulation of dopaminergic signaling in the reward circuit in response to social reward cues, such as smiling faces, friendly vocalizations, and gestures (Depue & Morrone-Strupinsky, 2005; Skuse & Gallagher, 2009). There is vast evidence, both from human and animal studies, that OT-dopamine interaction is involved in the regulation of maternal behavior, pair bond formation, partner preference formation, selective aggression towards unfamiliar conspecifics, sexual behavior and social recognition (Liu & Wang, 2003; Love, 2013). However, another study done on humans showed that OT increased ratings of attractiveness of unfamiliar females as expected, but there was no OT modulation of dopamine release, which suggests some other mechanisms were at play (Striepens, et al., 2014). In non-social contexts, there are fewer studies about effects of OT in reward circuitry, and they are mostly related to its potential therapeutic use for drug addiction. OT has been shown to reverse tolerance and reduce withdrawal symptoms and dependence for many types of drugs (McGregor & Bowen, 2012). Evidence suggests that OT up-regulation of the dopamine system mediates some of these effects (McGregor, Callaghan, & Hunt, 2008; Baskerville & Douglas, 2010). Another recently emerging topic is the connection between novelty seeking, creative cognition and OT, which centers on the OT effects on circuits that underlie approach motivation, especially the dopaminergic system (De Dreu, 2012; De Dreu, Baas & Boot, 2015).

b) Avoidance

In the vast literature about fear conditioning, an avoidance behavioral reaction is marked as one of the outputs of the defense brain circuit, in which the amygdala has a central function (LeDoux, 2012; Cain & LeDoux, 2008). The amygdala is involved in the detection of both unconditioned and conditioned fear stimuli, and it sends signals to the hypothalamus and periaqueductal grey which direct autonomic and behavioral fear responses. The amygdala is also responsible for increasing general arousal, by sending signals to different neuro-modulatory and hormonal systems. In turn, stimuli that caused this rise of arousal are more likely to maintain high levels of arousal through a feedback system, which allows them to

dominate attentional resources over other stimuli. Through this system, the amygdala facilitates cognitive processing and learning of adaptively important information. While traditionally the amygdala was thought to be specialized for fear and anxiety processing, now the more dominant view is that it is sensitive for relevance cues in the environment, regardless of their valence (Sander, Grafman, & Zalla, 2003; Seeley et al 2007; Cunningham et al 2012). The amygdala has broad connections to different cortical and subcortical regions that encode both information about external stimuli and about current needs of the organism, which makes it a perfect structure for computing relevance (Sander et al., 2003). Importantly, the amygdala also receives input from different regions in the prefrontal cortex, which might provide inputs resulting from cognitive evaluation of stimuli (Cunningham et al., 2008). Furthermore, signals from the pre-frontal cortex have been suggested to promote emotional control through inhibitory effects on amygdala activity (Etkin, Büchel, & Gross, 2015).

As was mentioned in the subchapter about evidence in non-social contexts (2.3.2), there are several neurobiological and brain imaging studies that help us understand the role of OT in amygdala function. Invivo studies done on fear-conditioned rats show that application of OT in the amygdala decreases freezing behavior (an avoidance behavior) and cardiovascular responses (Viviani, et al., 2011, Knobloch, et al., 2012), and inhibits input signals to the central amygdala from cortical regions important for forming an autonomic response to fear (Huber et al., 2005). Kirsch et al. showed that OT decreased amygdala activation for both social and non-social images, and reduced connectivity between the amygdala and the brain stem (periaqueductal grey and reticular formation) (Kirsch, et al., 2005). Finally, Petrovic et al showed that OT neutralized the effect of fear-conditioned stimuli presentation on amygdala activation, but only if the stimuli were relevant (faces with a directed gaze, compared to the faces with averted gaze) (Petrovic, Kalisch, Singer, & Dolan, 2008). More studies are needed to confirm the effects of OT on cortico-amygdala circuitry in non-social contexts in humans. Notably, OT has also been shown to strengthen the connection between rostral medial PFC and amygdala, a connection important for emotional regulation among other functions (Sripada, et al., 2012).

3 Present Study

3.1 Social closeness - from social buffering to approach/avoidance effects

The presence of another conspecific in a stressful situation, especially if they are close to each other, has been shown to attenuate stress response via a decrease in HPA axis activity and fear-related withdrawal behavior, which is referred to as *the social buffering effect* (Kiyokawa et al., 2014; Hennessy et al., 2009). Familiarity or social closeness of the buffering partner is indeed the most important factor allowing for the buffering effect to occur (Kikusui et al., 2006). As an example from animal studies, Kiyokawa et al. showed that, in comparison to an unknown partner, the presence of a familiar partner led to a decrease in freezing behavior, further accompanied by decreased Fos expression in the PVN and the LA (Kiyokawa et al., 2014). Most studies in humans show buffering effects by family and friends (e.g. Gunnar & Hostinar 2015). However, there is a lack of evidence from studies relying on the experimental induction of social closeness in humans. Only one study showed that induced social closeness reduced self-reported stress levels (Robinson, et al., 2017).

It has been repeatedly suggested that the social buffering effect, both on the physiologic stress response and on behavior, is primarily regulated by the *oxytocinergic system* (Kikusui et al., 2006; Smith & Wang, 2014; Chen, et al., 2011). Oxytocin (OT) is a hormone and neuropeptide produced in the PVN, released into the blood through the pituitary gland, and is also active in several limbic regions in the brain aside from the hypothalamus, such as the amygdala and the NAc (Kikusui et al., 2006). Oxytocin released in the PVN has been shown to reduce the activity of the HPA axis in stressful situations (Smith & Wang, 2014), and OT release in the amygdala has been shown to be important for the reduction of anxiety-related behaviors, both in animals (Neumann, 2002; Ebner et al., 2005, Knobloch, et al., 2012) and humans (Heinrichs et al., 2009; Kirsch et al 2005). Finally, Kikusui et al. proposed that the presence of a close partner increases the concentration of OT in several areas of the brain, including the PVN, the NAc and the amygdala. According to this model, the OT activity in all these circuits contributes to the reduction of stress responses and anxiety-related behaviors, and the facilitation of social bond formation (Kikusui et al., 2006). Many aspects of this model are yet to be confirmed in humans.

Recent studies in humans suggest that OT administration in interaction with the social context leads to broader effects than simple stress-response reduction. Shamay Tsoory et al (2009) placed participants in a competitive environment where they played a game of chance with an anonymous partner, against whom they could either win or lose money (Shamay-Tsoory et al 2009). Contrary to the usual prosocial effects of OT, it facilitated feelings of gloating and envy towards the anonymous person. Authors stated that OT probably increases the salience of the relevant social context, both when it is positive and

negative, and intensifies adaptive affective reactions to the social environment. Thus, the social context can crucially modulate the effects of OT. Another study showed that OT facilitates cooperation with familiar partners and decreases cooperation with unknown partners (Declerck et al., 2010). The interaction between OT and familiarity of the interaction partner implies that the direction of the OT effects on behavior depends on the familiarity of the social context.

There are two recent hypotheses of OT mechanisms in the brain relevant for this study: *the social approach/avoidance hypothesis of OT* (Kemp & Guastella, 2011) and *the general approach/avoidance hypothesis of OT* (Harrari-Dahan & Bernstein, 2014). Based on the bulk of existing findings, these two groups of authors claim that the documented effects of OT on animal and human behavior can be explained by its effect in the *approach/avoidance systems* of the brain. The main difference between these two hypotheses is that they presume different kinds of cues from the environment to trigger these effects. Kemp and Guastella claim that the OT effects on approach/avoidance behavior manifest themselves only in behavior towards other humans, supporting the currently prevailing view that OT is a socially specific neuropeptide (Adolphs, 2010), and more generally, *the social brain hypothesis* (Dunbar, 1998). Harari-Dahan and Bernstein, on the other hand, propose that OT regulates approach/avoidance behavior towards both social and non-social stimuli, as long as they are personally relevant and emotionally evocative (Harari-Dahan & Bernstein, 2014). This is more in line with *the common currency hypothesis*, stating that social and non-social rewards are processed by the same general motivational circuits, which are neither anatomically nor functionally separate for social and non-social stimuli (Ruff & Fehr, 2014).

Corroborating the idea that OT acts on the general approach/avoidance systems of the brain, it has been shown that OT up-regulates the dopaminergic 'reward' system (e.g. Baskerville & Douglas, 2010; Skuse & Gallagher, 2009). The oxytocin-dopamine interaction is proposed to be responsible for the regulation of various social approach-related behaviors (e.g. maternal behavior, behaviors important for pair-bond formation, etc.) (Love, 2013), but also for the regulation of behavior related to addiction, i.e. beyond the social domain (McGregor, et al. 2008; Yang et al., 2013). On the other hand, it was repeatedly shown that OT has inhibitory effects in the amygdala, which mediates reduction of avoidance behavior in animals (Ebner et al., 2005; Knobloch, et al., 2012; Viviani, et al., 2011). In humans, OT administration reduced the activation of the amygdala, and its connectivity to the brain stem, during the observation of fearful social and non-social stimuli (Kirsch, et al., 2005, Gamer et al., 2000). Importantly, the abovementioned structures are involved in regulating approach/avoidance behavior (e.g. Harmon-Jones, 2011), as well as encoding the motivational relevance of stimuli (e.g. Sander et al., 2003; Berridge et al., 2009). There is empirical evidence that OT increases approach and decreases avoidance behaviors in animals (e.g. Lukas, et al., 2011; Arakawa et al., 2010). Yet, there are only a few experimental studies directly showing the effects of OT on approach and avoidance responses in humans towards social stimuli (Radke et al.,

2013; Cohen, et al., 2017), and only one study also showing these effects towards non-social stimuli (Harari-Dahan & Bernstein, 2017).

It can be concluded that OT has much broader effects than mere stress-reduction. Aside from the studies examining its isolated effects, OT has been shown to exert effects on approach/avoidance behavior in interaction with the social context in which the tasks were performed. Kemp and Guastella pointed out that OT seems to facilitate approach-related social emotions (both positive, such as joy and trust, and negative, such as anger and envy) depending on the affective tone of the social context (Kemp & Guastella, 2011). This idea is further supported by Kubzansky et al (2012), who showed that, when a friend was present in a stressful situation, OT further facilitated an approach, or "challenge" cardiovascular profile of the autonomous nervous system, preparing the body to engage with the environment, as opposed to an avoidance, or "threat" cardiovascular profile, preparing the body for the withdrawal (Olff, et al., 2013; Kubzansky et al., 2012). Moreover, as the traditional social buffering studies also show (Davis, 1955; Kiyokawa et al., 2014), OT does not only reduce the physiological stress response but also anxiety-related avoidance behaviors. Finally, the model of OT mechanisms of social buffering by Kikusui et al includes all of the brain structures previously mentioned to also underlie the OT effects on approach and avoidance behavior, such as the NAc and the amygdala.

Based on the reviewed literature, the following conclusions can be drawn. The presence of a familiar person can have stress-ameliorating effects, which are proposed to be primarily mediated by OT release in the hypothalamus and the amygdala. Furthermore, the presence of a familiar person and administration of OT have similar effects, which have also been shown to interact (Heinrichs et al., 2003). OT has been shown to facilitate approach behavior and reduce avoidance behavior via the midbrain 'reward' circuitry and the cortico-amygdala fear circuitry, the neurobiological pathways crucially involved in approach/avoidance motivation. According to Kemp and Guastella, OT specifically affects approach and avoidance towards social stimuli, but according to Harari-Dahan and Bernstein, OT affects approach and avoidance towards personally relevant and emotionally evocative stimuli, irrespective of their social or nonsocial content. All this provides a basis to assume that the presence of familiar persons could on its own have broader effects than mere stress reduction and reduction of anxiety-related behavior. The brain mechanisms that mediate the social buffering effect are also involved in the regulation of approach and avoidance behavior towards relevant stimuli in the environment. The presence of a socially close individual could achieve its buffering effects through oxytocinergic mechanisms; therefore, the presence of a socially close individual possibly also has an effect on approach/avoidance motivation. Taking the above-mentioned findings and theories into account, it is plausible to ask whether the presence of socially close people may also have general effects on approach and avoidance behavior towards highly relevant positive and negative, social and non-social stimuli.

3.2 Research questions

Oxytocin administration and presence of a socially close person in a stressful situation have been shown to have similar effects – a reduction of fear and anxiety (e.g. Heinrichs et al., 2003), and a decrease of fear-related avoidance behaviors, such as freezing in rats (e.g. Kiyokawa et al., 2014). As stated earlier, OT has been suggested to be the main mediator of the social buffering effects. It has been proposed that the presence of a close person activates the same mechanisms that lead to the anxiolytic effects of OT administration (Kikusui et al., 2006). Kikusui et al. claim that the presence of a familiar person increases the concentration of OT in the brain, which leads to multiple effects in different brain structures – OT in PVN of the hypothalamus is responsible for the inhibition of HPA axis activity (Smith & Wang, 2014); OT in the amygdala has inhibitory effects both on the stress-response (via the amygdala-hypothalamus connection), and on anxiety-related behavior, (via the amygdala-brain stem connection) (Neumann, 2002; Kirsch, et al., 2005)); OT in NAc facilitates bond formation with the buffering partner (Love, 2014; Kikusui et al., 2006). When it comes to the research on OT alone, it is not only considered to have isolated effects on specific social behaviors and stress reduction, but also more general effects on the circuits regulating approach/avoidance motivation - among others, the amygdala and the NAc (Kemp & Guastella, 2011; Harari-Dahan & Bernstein, 2014). If similar OT mechanisms regulate social buffering effects and approach/avoidance behavior, one could also expect that the presence of a socially close person has a broader effect than the stress-reduction and reduction of anxiety-related behaviors. Through the same OT mechanisms, the presence of a socially close person on its own might affect general approach/avoidance behavior towards relevant stimuli from the environment. The primary aim of this thesis was to test whether the effects predicted by the social approach/avoidance hypothesis and the general approach/avoidance hypothesis of OT could also be elicited by social closeness induction alone. The first research question of this thesis is therefore as follows: (1) Does the presence of socially close individuals increase approach and decrease avoidance behavior towards relevant and emotional stimuli in the environment?

Since OT is traditionally known to regulate adaptive social behaviors, such as maternal and reproductive behavior, but also bond formation and social cognition, the research of OT is very often limited to its social functions, presupposing it is a 'prosocial hormone' (Love, 2014). Accordingly, most of the theories of OT take only the effects on social behavior into account: the prosocial hypothesis of OT (Kemp & Guastella, 2011), the social salience hypothesis of OT (Shamay-Tsoory & Abu-Akel, 2016) and the social approach/avoidance hypothesis of OT (Kemp & Guastella, 2011). However, there are also findings of OT modulation of behavior towards non-social threats. Mostly the findings on rats show that OT reduces avoidance behavior in non-social stressful situations (Onaka et al., 2012; Yoshida et al., 2009). Several studies show inhibitory effects of OT in the amygdala while engaging with non-social threat stimuli

(Knobloch et al., 2012; Viviani, 2011; Kirsch et al 2006). Finally, Harari-Dahan and Bernstein hypothesize that OT acts on the mechanisms regulating approach and avoidance towards all types of personally relevant and emotionally evocative stimuli, regardless of whether they are social or non-social (Harrari-Dahan & Bernstein, 2014).

Importantly, the literature on social buffering does not suggest that the presence of familiar conspecifics reduces HPA axis reaction specifically to social or non-social stressors, but stressors in the broadest sense (Kiyokawa & Hennessy, 2017). In many studies of social buffering in animals, the stressors were fear-conditioned non-social stimuli and situations (Kiyokawa et al., 2014; Smith & Wang, 2014). However, studies of social buffering on humans mostly elicit stress using the Trier Social Stress Task (TSST), which puts a person in a stressful *social* situation (Heinrichs et al., 2003; Chen, et al., 2011). Based on these findings, it is not possible yet to conclude whether the presence of a familiar buffering partner achieves its effects only in relation to social emotional stimuli, or more generally, to any kind of relevant stimuli. The second research question is, therefore, as follows: (2) **Does the presence of social y close individuals affect approach/avoidance behavior in the same way towards social and non-social stimuli, as long as they are relevant and emotional?**

Another important aspect of the topic is the personal relevance of the stimuli. The social salience hypothesis states that OT increases the salience of relevant social cues in the environment, both positive and negative, and thus increases attentional response to these cues (Shamay-Tsoory & Abu-Akel, 2016). The general approach/avoidance hypothesis of OT (GAAO) states that OT increases approach and decreases avoidance only to personally relevant and emotionally evocative stimuli, no matter whether they are social or non-social (Harari-Dahan & Bernstein, 2014). What both have in common is that they agree that OT mechanisms are at play only when a certain object, event or response option is relevant for the individual. The neural circuits proposed by GAAO to be modulated by OT (the NAc and the amygdala) are highly important for determining the relevance and salience of stimuli (Berridge et al., 2009; Cunningham & Brosch, 2012). Furthermore, the study in which the authors of GAAO tested this hypothesis showed that OT decreased avoidance of negative emotional stimuli only in a population of individuals with a high Anxiety Sensitivity Index. Individuals with high anxiety sensitivity have a tendency to assign a high importance to their own arousing emotions and to fear such sensations; therefore, the negative arousing stimuli were more relevant to them compared to the people with low anxiety sensitivity (Taylor, et al., 2007). Accordingly, this study also included the factor of anxiety sensitivity, in order to test whether social closeness induction has a stronger effect on avoidance of negative arousing stimuli in highly anxiety sensitive individuals. Notably, if this study replicated the findings of Harari-Dahan and Bernstein (2017), but with social closeness as the independent variable instead of OT, that would have been consistent with the idea that the OT could mediate the expected effects. The third research question follows: (3a) Does the

presence of socially close individuals have a stronger effect on the avoidance of negative relevant and emotional stimuli in participants with high anxiety sensitivity?

For the same reasons, two more variables reflecting individual differences were included – *behavioral activation system (BAS)* and *behavioral inhibition system (BIS)*. A questionnaire measuring these constructs was developed by Carver and White and is based on Gray's biopsychological theory of personality (Carver & White, 1994; Gray, 1981). According to this theory, the BAS score indicates one's sensitivity to reward, and is related to generally higher approach motivation, while BIS score indicates one's sensitivity to punishment, and is related to higher avoidance motivation. Individual differences on this trait could also interact with the effects of social closeness on approach and avoidance behavior. Therefore, another question would be: (3b) Does the presence of socially close individuals have a stronger effect on approach towards positive and avoidance of negative relevant and emotional stimuli in participants with high BAS and with high BAS scores?

3.3 Hypotheses and expected results

In this thesis, the above-mentioned research questions were addressed through an experimental setup with a social closeness induction task and a key-press approach/avoidance task based on several approach/avoidance paradigms used in previously mentioned studies of approach/avoidance behavior in humans (e.g. Harari-Dahan & Bernstein, 2017; Theodoridou et al., 2013). In this study, social closeness is induced by increasing the sense of similarity between individuals. It has been shown that learning that other individuals have similar mental states (personal preferences, beliefs and cognitions) to us, makes us like them more, feel closer to them and find them more familiar, compared to a situation in which others have dissimilar mental states (Majdandžić, Amashaufer, Hummer, Windischberger, & Lamm, 2016). The authors proposed that the representation of similar individuals, compared to the representation of dissimilar individuals, requires less self-inhibition and self-adjustment and more self-projection, which leads to a more complete representation of others as human beings and generally more pro-social tendencies towards them (Majdandžić et al., 2016). In line with the reviewed literature, we expected that this similarity induction paradigm would induce social closeness between individuals, which could then affect approach and avoidance behavior. There are four main hypotheses.

Firstly, we expected that social closeness would increase approach of positive social stimuli (*hypothesis 1a*) and decrease avoidance of negative social stimuli (*hypothesis 1b*). More specifically, we expected that participants subjected to the similarity induction, which made them feel socially close to the other individuals in their presence, would show an increase in the number and speed of approach responses to social positive images, and a decrease in the number and speed of the avoidance responses to social negative images after this induction, compared to participants led to feel dissimilar to the other individuals.

Secondly, we expected that social closeness would increase approach towards positive non-social stimuli (*hypothesis 2a*) and decrease avoidance of negative non-social stimuli (*hypothesis 2b*). More specifically, the induction of similarity was expected to increase the number and speed of approach responses towards non-social positive stimuli, and decrease the number and speed of avoidance responses towards non-social negative stimuli, compared to the induction of dissimilarity.

Regarding the trait variables anxiety sensitivity, behavioral activation system (BAS) and behavioral inhibition system (BIS), it can be expected that these traits affect the personal relevance of certain stimuli. Based on the assumption that the OT affects the behavior towards stimuli of high personal relevance, we also expected that social closeness would have a stronger effect on approach and avoidance of highly personally relevant stimuli. Harari-Dahan and Bernstein claimed that the negative arousing stimuli are especially relevant for individuals high on the cognitive aspect of anxiety sensitivity, which could underlie the stronger effects of OT on avoidance of negative stimuli in these individuals (Harari-Dahan & Bernstein, 2017). Accordingly, we expected the effect of social closeness on the decrease in avoidance of negative stimuli to be particularly strong in participants with anxiety sensitivity score (*hypothesis 3*). Similarly, participants higher on BIS, who are more sensitive to unpleasant sensations (Carver & White, 1994), were also expected to find the negative stimuli especially relevant. Participants higher on BAS, on the other hand, who are more sensitive to rewards and positive sensations, were expected to find positive stimuli highly relevant. Therefore, it was expected that the effect of social closeness on approach of positive stimuli to be particularly strong in participants high in BAS score (*hypothesis 4a*), and the effect of social closeness on avoidance of negative stimuli to be particularly strong in participants high in people high in the BIS (*hypothesis 4b*).

Since Harari-Dahan and Bernstein used the cognitive sub-scale of anxiety sensitivity in their paper (Harari-Dahan & Bernstein, 2017), the hypothesis 3 was checked both on the general anxiety sensitivity scale and on its cognitive sub-scale. Furthermore, since it has been recommended to use the three sub-scales of BAS separately (Carver & White, 1994), in addition to the aggregated BAS measure, the hypothesis 4a was also tested on the Reward Responsiveness sub-scale of BAS. This aspect of reward sensitivity is expected to be the most relevant for the performance in the approach/avoidance task administered in this study (read more in Chapter 5.3.3).

4 Interdisciplinary aspects and novelty of the thesis

Several theories mentioned in the theoretical review tried to capture the function of oxytocin in regulating various, mostly social behaviors. Some common conclusions are that OT is sensitive to motivationally relevant stimuli (Shamay-Tsoory & Abu-Akel, 2016), and that it enhances approach-related emotions and approach behavior and inhibits avoidance-related emotions and avoidance behavior in relation to these stimuli (Kemp & Guastella, 2011; Harari-Dahan & Bernstein, 2014). Most of the theories claim that these OT mechanisms are active only in response to social stimuli (e.g. Norman, et al., 2011), while others claim that they are active in response to relevant emotional stimuli, regardless of the type of the content (Harari-Dahan & Bernstein, 2014). The reviewed literature on the OT and the approach/avoidance behavior is already interdisciplinary in a sense that these studies try to understand more specific or more general tendencies in social and non-social behavior based on knowledge about neuropeptide mechanisms in the brain. The social buffering effect has also been researched in the context of different disciplines, such as psychoneuroendocrinology, behavioral neuroscience and social psychology. In contrast to theories on the effects of brain OT on emotions and behavior, the studies of social buffering address the effect of a psychological variable, (the familiarity of a present person) on biological parameters in the body (e.g. the level of cortisol).

OT is important for the occurrence of the stress-reducing effects of the presence of a familiar conspecific (Smith & Wang, 2014; Chen, et al., 2011), but on the other hand, it has been shown to have broader effects than this, e.g. it modulates cooperation behavior (Declerck et al., 2010). This thesis aims to show that the line of research on social buffering and the line of research concerning OT effects on approach/avoidance behavior might complement each other, and to examine the possibility that previously unrelated findings are in fact parts of the same puzzle. The studies investigating the effects of OT on approach/avoidance behavior do not deal with the specific contextual factors that could trigger the OT effects. The presence of a social close person is a good candidate for a social situation that could be the trigger for the proposed oxytocin effects on approach/avoidance behavior – that is, a positive social context and the presence of socially close individuals has already been shown to increase the levels of oxytocin in the body and brain (Seltzer et al., 2012; Kikusui et al., 2006). The social buffering research, on the other hand, does not acknowledge that the stress-reduction is possibly only part of the wider effect that the presence of a socially close person might have on the body and behavior.

Regarding the methodological novelty of this study, it is important to note that social closeness was not experimentally induced in the previous studies of social buffering in humans. In most studies, the friends and family were brought as social buffering partners. As the relationship with friends and strangers can widely vary from individual to individual, the similarity induction method that we used has its benefits. In this task, the experimental and the control group have symmetrical induction manipulations (similarity vs. dissimilarity) which have been previously shown to modulate interpersonal closeness and affiliation measured by the self-ratings (Majdandžić et al., 2016). Moreover, as this method induces social closeness through sense of *similarity* vs. *dissimilarity* between the members of a group, the findings of this study could also be relevant for understanding how being surrounded by similar vs. dissimilar persons affects general approach and avoidance tendencies. This aspect is relevant, since in everyday life we are surrounded and expected to cooperate both with people who are similar and dissimilar from us. Therefore, it would be also useful to know how our tendency to approach and withdraw differs when surrounded by like-minded and different individuals.

In conclusion, this thesis tried to bridge two seemingly separate lines of research, which is the main source of its novelty. We asked whether a psychological variable, i.e. the social closeness of the present persons, has effects similar to the effects which would be expected from oxytocin administration. Although we did not include oxytocin in the study, we created a social context that could be expected to trigger the mentioned effects of OT in the previous studies. If we showed that the social closeness alone had similar effects on approach/avoidance behavior as OT, it could also have implications for future research of oxytocin. The interdisciplinarity of this study mainly stems from the theoretical background that was used to build it – psychopharmacological theories, neuroscience studies and social psychology studies. It brings together these separate line of research to form new research hypotheses that could be relevant for each of these independent lines of research it is based on.

5 Experimental Design and Methods

5.1 Participants

The data was collected from 62 female participants, aged between 18 and 42 (M = 23.6, SD = 5.31). In order to fulfill prescreening criteria, participants needed to either regularly take contraceptive pills or be in the mid-luteal phase of the menstrual cycle at the time of the testing. These criteria were based on the previously mentioned study by Harari-Dahan and Bernstein (2017), as we were presuming that the oxytocinergic system would be involved in the effects of the experimental manipulation (Harari-Dahan & Bernstein, 2017). The participants were recruited through the SONA system of the Laboratory Administration of Behavioral Sciences (LABS) of the Faculty of Psychology, University of Vienna. Around 200 participants previously completed the prescreening questionnaire advertised through the LABS system, and the ones who met the requirements of the study were invited to participate via email. All participants

received 10 euros for participation in the experiment, provided by the Social, Cognitive and Affective Neuroscience Unit (SCAN-Unit) of the Faculty of Psychology, University of Vienna.

During data pre-processing 3 participants were excluded from analyses, as there was evidence that the experimental manipulation was not efficient in their cases. Thus the final sample size was 59 participants, aged between 18 and 42 (M = 23.34, SD = 5.12). The exclusion procedure is described in more detail in the data analysis (Chapter 5.5) and results (Chapter 6.1.1) sections.

5.2 Experimental design and manipulation

5.2.1 Design and overview of the methods

This study had 2 x 2 x 2 x 3 design with one between-subject factor, group (similarity and dissimilarity), and the following within-subject factors: sociality (social and non-social), valence (positive, neutral and negative), and pre-post (before and after experimental manipulation). Social closeness was induced using a modification of the Similarity Induction Task (SIT) (Majdandžić et al., 2016) conducted in groups of four participants. In this task, participants of similarity groups were led to believe that they have similar personal mental states, while participants of dissimilarity groups believed that their mental states are dissimilar from others'. Approach and avoidance behavior was measured towards stimuli with varying sociality (social or non-social) and valence (positive, negative or neutral) using the Size Modification Task (SMT). In this task, participants observed one stimulus at the time and had an opportunity to increase the size of each stimulus by clicking the 'up' key (approach response) and/or decrease its size by clicking the



Figure 1. The experimental time course

'down' key (avoidance response). This task was administered both before and after the experimental manipulation (pre-SIT and post-SIT). We gathered three measures of approach/avoidance behavior for each trial: the number of approach and avoidance responses, the speed of approach/avoidance responses and the image size. Additionally, the following questionnaires were administered: The Anxiety Sensitivity Index (ASI) (Kemper & Finnern, 2007) and The BIS/BAS inventory (Strobel, Beauducel, Debener, & Brocke, 2001). After the SIT, participants completed the affiliation and interpersonal closeness scale, used to check the effectiveness of the experimental manipulation. After each run of the SMT, positive and negative affective states were measured using The Positive Affect Negative Affect Scale (PANAS) (Breyer & Bluemke, 2016). The order of administration of these tasks and questionnaires is shown in Figure 1.

5.2.2 The Similarity Induction Task

Social closeness was experimentally induced using a modification of the Similarity Induction Task (Majdandžić et al., 2016). This version of the task is performed in groups of 4 participants. The participants in the same group were required to not to know each other from before, and were not allowed to verbally communicate during the task. In the task they were presented with 24 pairs of opposing statements referring



Figure 2. Preview of a trial in the Similarity Induction Task: a) fixation cross (1s), b) two opposing statements are presented (3s), c) the white lines signal that participants can now select one of the statements, d) the answer is chosen (white square) and the answers of others (blue squares) appear at different time intervals from 0 to 2500ms after the participant's answer; the statements and the answers stay on screen for 3 more seconds. In this trial one answer matched to the participant's answer and two were different

to different personal mental states, such as preferences, desires and cognitive states (e.g. "I like to have many responsibilities in life" vs. "I like to be free from obligations, if possible"). For each pair, the task was to spontaneously choose from the two statements the one that applied to them the most, by pressing the 'left' or the 'right' key on the keyboard. They would subsequently see the alleged answers of the other participants on the screen. Before the beginning of the task there was a practice trial, followed by 24 trials (one pair of statements per trial). The time course of one trial is shown in Figure 2.

The alleged answers of other participants shown on the screen were pre-programmed and did not reflect their actual answers. In the *similarity condition*, roughly 80% of the "answers" of the others matched the answers of the participant (in 10/24 trials all other answers matched, in 10/24 trials 2 other answers matched, in 2/24 trials one other answer matched and in 2/24 trials no other answers matched). In the *dissimilarity condition*, roughly 80% of the "answers" of the others did *not* match to the answers of the participant (in 18/24 trials no other answers matched, in 2/24 trials one other answers matched, in 2/24 trials 2 other answers of the participant (in 18/24 trials no other answers matched, in 2/24 trials one other answers matched, in 2/24 trials 2 other answers matched, in 2/24 trials 2 other answers matched, in 2/24 trials 2 other answers matched, in 2/24 trials one other answer matched, in 2/24 trials 2 other answers matched).

Each pair had two mutually exclusive statements with similar probabilities to be chosen, as shown on a larger sample (Majdandžić et al., 2016). None of the statement pairs implied socially desirable personal characteristics. We decided to use this task to induce a sense of social closeness between the participants because it has been shown to successfully elicit self-reported affiliation and interpersonal closeness, measured by the sub-scales *likability*, *connectedness*, *similarity*, *cooperativeness*, and *familiarity* (Majdandžić et al., 2016). Based on this finding, we expected that the participants in *the similarity condition* would feel more close and familiar to each other relative to the participants in *the dissimilarity condition*.

5.3 Experimental measures

5.3.1 Experimental manipulation check

After the 24 SIT trials, eight more trials with the new pairs of statements were presented. In these trials, participants were not able to see the other 3 answers any more, but only their own. In the first four trials, the task was to pick the statement that they expected the other persons in the room would chose (marked with a blue square). In the other four trials, the task was to pick their own answer for the same 4 pairs of statements (marked with a white square). These statements had both a purpose of additionally inducing social closeness, as thinking about mental states of others also facilitates social closeness (Majdandžić et al., 2016), and served as an additional measure of social closeness. Then, the self-report measure of affiliation and interpersonal connectedness was administered (Majdandžić et al., 2016). It consisted of 6 Likert-type questions answered on a 7-point slider (- 3 - "not at all" to +3 - "very much").
These questions were (translated from German)²: 'Indicate the degree to which you feel like you got to know the other players during the meeting game', 'How connected do you feel to the other players?', 'How likeable do you find the other players', 'How familiar the other players occur to you', 'How similar (to yourself) the other players occur to you?', 'I have an impression that the participants in my group have a lot in common'. Additionally, the Inclusion of Other in the Self (IOS) Scale was administered (Aron, Aron & Smollan, 1992). This graphic scale has two circles representing the 'Self' and the 'Other' and the task is to indicate which of the 7 overlap levels of these two circles represents one's relationship to the others the best.

5.3.2 The Size Modification Task

In the Size Modification Task (SMT), participants were presented with 60 pictures representing 6 stimulus categories: 2 (social/non-social) x 3 (positive/neutral/negative). In each trial, they could spontaneously modify the size of the presented picture for 4 seconds, and then observe the picture in its final size for 2 more seconds. During the last two seconds, a blue frame would appear around the picture, signaling that the size could no longer be changed. The size was increased by pressing the 'up' key, and decreased by pressing the 'down' key on the keyboard. In each trial, participants were allowed to press 'up' and 'down' keys as many times as they wished. The default size of the image was 400 x 300 pixels. By pressing 'up', it could grow up to double size (800 x 600), and by pressing 'down', it could shrink down to half size (200 x 150). Maximum number of clicks was 29 in both directions. Figure 3 shows the structure of two trials.

This task has both similarities and differences with respect to existing approach/avoidance tasks (AAT). The mostly used AAT is *the joystick task*, in which the joystick is either pushed (avoidance) or pulled (approach) in a response to the picture on the screen (Theodoridou, et al., 2013). In some versions of this task, joystick movement does not change the picture presented on the screen (e.g. Chen & Bargh, 1999), but in *the feedback joystick tasks*, the picture zooms-in, when one pulls the joystick, or zooms-out, when one pushes the joystick (Phaf, Mohr, Rotteveel, & Wicherts, 2014). In that sense, our task is similar to the zooming AAT. The other group are the tasks in which one can modify the time of the picture presentation (Aharon, et al., 2001; Harari-Dahan & Bernstein, 2017; Chelnokova, et al., 2014). In these tasks, the picture has a default time of presentation (e.g. 6s), which can be spontaneously increased by pressing the 'up' key, and decreased by pressing the 'down' key on the keyboard. The Size Modification Task is similar to these tasks in a sense that it takes clicks of the 'up' key as an approach response, and

² 'Wie sehr haben Sie das Gefühl Ihre Mitspieler über das Kennenlernspiel kennengelernt zu haben?', 'Wie verbunden fühlen Sie sich mit Ihren Mitspielern?', 'Wie sympathisch finden Sie Ihre Mitspieler?', 'Wie vertraut kommen Ihnen Ihre Mitspieler vor?', 'Wie ähnlich (zu Ihnen selbst) kommen Ihnen Ihre Mitspieler vor?', and 'Ich habe den Eindruck dass die Teilnehmer in meiner Gruppe viel gemeinsam haben'.

clicks on the 'down' key as an avoidance response. It is relevant to note that during the course of this project, we developed both the Size and the Time Modification Task. Based on pilot findings, we decided to use the Size Modification Task in this study (see Appendix 1).

Furthermore, this task can be compared to the other AATs with regard to the way approach and avoidance behavior is measured. In most versions of the joystick task, participants are explicitly asked to respond to the pictures in a certain way depending on the picture valence (Chen & Bargh, 1999). In our task, response to the pictures was completely spontaneous, as the choice whether to approach or avoid was up to the participant. We collected three measures in each trial: 1) the number of approach (for positive stimuli) or avoidance (for negative stimuli) clicks; 2) the speed of approach (for positive stimuli) or avoidance (for negative stimuli) clicks, calculated by dividing the number of clicks in each trial with the number of seconds between the first and the last click in that trial; and 3) the final image size, which was based on the difference between the number of approach and avoidance clicks on each trial.

The image size measure was included in order to account for the incongruent responses, i.e. approach to negative and avoidance of positive stimuli. The image size measure had a central value of 0, a theoretical maximum at 29 (for the maximal possible number of approach responses) and minimum at -29 (for the maximal possible number of avoidance responses). This means that, if participants gave more



Figure 3. Examples of two trials in the SMT; a) the participant clicked DOWN several times (avoidance), or b) the participant clicked UP several times (approach) during the 4s period; after that the blue frame appears and the picture stays on the screen in its final size for two more seconds.

approach than avoidance responses in a trial, the image size value was positive, and if they gave more avoidance than approach responses in a trial, the value was negative.

The speed of approach/avoidance clicking was included after the conclusions drawn from the pilot study (Appendix 1). In the pilot study it was noticed that non-social stimuli consistently elicited more approach and avoidance responses than social stimuli, which might have been due to a difference in response latency between social and non-social trials. This was the main motivation for additionally including speed of clicking as an alternative approach/avoidance measure in the main study, because this measure was expected to be insensitive to potential differences in response latency.

5.3.2.1 Emotional picture stimuli

In this task, 120 stimuli were used, 20 for each category: 2 (social / non-social) x 3 (positive / neutral / negative). Since participants did the task two times, before and after the experimental manipulation, the 120 stimuli were split in two sets of 60 stimuli (10 per stimulus category), matched for the valence and the arousal ratings (see below).

The selection process of the stimuli had several steps. First, 180 stimuli were picked from the IAPS (Lang, Bradley & Cuthbert, 2008), the NAPS (Marchewka, Żurawski, Jednoróg, & Grabowska, 2014), the EmoMadrid emotional pictures database (http://www.uam.es/CEACO/EmoMadrid), and through the search on Google Images (labeled for noncommercial reuse with modification). The aim was to select arousing picture stimuli for the positive and negative categories, and non-arousing picture stimuli for the neutral categories. Second, valence and arousal ratings for all stimuli were obtained in a sample of 30 students of the University of Vienna, recruited through the SONA system of the Laboratory Administration of Behavioral Sciences (LABS) of the Faculty of Psychology. Each stimulus was rated on a 9-point valence scale ("You are experiencing this image as..." 1 – very negative, 9 – very positive), and on a 9-point arousal scale ("Confronted with this image, you are feeling..." 1 – relaxed, 9 – aroused). Third, based on these

M (SD)	SET 1		SET 2	
	arousal	valence	arousal	valence
social positive	4.986 (.448)	7.161 (.323)	4.897 (.208)	7.237 (.337)
non-social positive	4.897 (.562)	7.227 (.521)	4.862 (.486)	7.272 (.559)
social neutral	4.28 (.384)	5.203 (.412)	4.32 (.237)	5.17 (.411)
non-social neutral	4.293 (.304)	5.222 (.339)	4.311 (.27)	5.195 (.339)
social negative	6.888 (.404)	2.532 (.478)	6.93 (.264)	2.521 (.391)
non-social negative	6.769 (.312)	2.457 (.397)	6.824 (.398)	2.485 (.465)

Table 1: Mean valence and arousal ratings and stand. deviations for each stimulus category and set

Valence rating scale: 1- very negative -9 - very positive, Arousal rating scale: 1- calming -9 - exciting

ratings, a pairwise match of social and non-social stimuli within each valence category (positive, neutral and negative) was performed, so that only the stimuli that could be well paired with the opposite social category were chosen. The number of stimuli was reduced from 30 to 20 per stimulus category. Every social stimulus had its non-social equivalent within the same valence category, on both valence and arousal ratings. The negative stimuli were the exception, since the arousal ratings significantly differed between social negative and non-social negative stimuli (T(32) = 3.033, p = .005), as the social had higher arousal (M = 6.81, SD =.72) than the non-social (M = 6.51, SD =.72). This made the pairwise matching unfeasible for negative stimuli Therefore, global matching was performed for the negative stimuli instead, meaning that the average arousal and valence ratings of all social negative stimuli were matched with the average ratings of all non-social positive, social neutral, non-social neutral, social negative and non-social negative.

The last step was to split each category on the two sets – one to be used before, and one after the Similarity Induction Task. The split was performed with the following limitations: (1) the matched pairs of social and non-social stimuli of the same valence category were never split in this process, and (2) the average valence and arousal ratings for each stimulus category were matched between sets (checked with T-tests). The final outcome were two sets of 60 stimuli, each having 10 pictures per stimulus category. In Table 1, the average arousal and valence ratings for each stimulus category of each set can be seen. It is important to note that negative stimuli show higher arousal (M = 6.85, SD = .71) than positive stimuli (M = 4.89, SD = .97) (T(32) = 8.86, p < .0001), in spite of the efforts to find positive and negative stimuli matched for arousal. However, it is important that positive stimuli have both higher valence (M = 7.24, SD = .72) than neutral (M = 5.2, SD = .28) (T(32) = 16.4, p < .0001), and higher arousal than neutral (M = 4.3, SD = .86) (T(32) = 2.55, p < .016). Also, negative stimuli have lower valence (M = 2.5, SD = .77) than neutral (T(32) = -20.35, p < .0001), and higher arousal than neutral (T(32) = 11.89, p < .0001).

Every participant saw each of the 120 stimuli once. In both versions of the task, the pictures were pseudo-randomized so that the stimuli from the same category cannot appear more than 2 times in a row. Four pseudo-randomized sequences of stimulus categories were generated in a custom MATLAB function. Each of these sequences was used the equal number of times in each participant group (similarity and dissimilarity), and each participant always had the same sequence of stimulus categories in the first and the second run of the task. With every run of the task, the sequence of stimulus categories was filled with shuffled stimuli from the respective categories and from the certain set. Which set would be presented in the first and which in the second task run was decided based of the parity of the participant number.

5.3.3 Questionnaires

5.3.3.1 Positive Negative Affect Scale (PANAS)

A German version of the PANAS, a commonly used mood scale (Breyer & Bluemke, 2016; Watson, Clark, & Tellegen, 1988) was used to assess general affect two times during the experiment: after the first, and after the second run of the SMT. This scale consists of 20 adjectives referring to different affective states (e.g. "excited", "distressed", "upset"). For each of these adjectives, participants indicated to which extent it applied to them on a 5-point Likert-type scale (1 - ``not at all'', 2 - ``a little'', 3 - ``moderately'', 4 - ``quite a bit'', 5 - ``extremely''). Two separate scores that could range from 0 to 50 were calculated by adding up the answers on all positive adjectives, the positive affect (PA), and on all the negative adjectives, the negative affect (NA).

5.3.3.2 Anxiety Sensitivity Index (ASI-3)

Anxiety sensitivity is best described as fear of one's own arousal sensations, based on beliefs these sensations lead to death, insanity or rejection (Taylor, et al., 2007). The sub-scale Cognitive Concerns (ASI-Cog) has shown to moderate the effect of OT on approach/avoidance responses in a previous study (Harari-Dahan & Bernstein, 2017). This study found effects of OT on avoidance behavior only in individuals with a high score on the ASI-Cog, presumably because the individuals high on this sub-scale attribute higher relevance to negative, highly arousing stimuli. Since our study design is in many points similar to the one of Harari-Dahan and Bernstein, we decided to also include a German version of the anxiety sensitivity questionnaire (ASI-3) (Kemper & Finnern, 2007), and to use both the total ASI and the ASI-Cog score in our analyses.

This questionnaire has 18 items split on the three sub-scales: Physical Concerns (e.g. "When my stomach is upset, I worry that I might be seriously ill"), Cognitive Concerns (e.g. "When my thoughts seem to speed up, I worry that I might be going crazy"), and Social Concerns (e.g. "I worry that other people will notice my anxiety"). The items are answered on a 5-point Likert-type scale (0 – "strongly disagree", 1 – "disagree", 2 – "neither agree or disagree", 3 – "agree", 4 – "strongly agree"). Three separate scores for three sub-scales are calculated by adding up the answers from the respective statements. Each of the subscores can range from 0 to 24. A total score represents the sum of answers on all 18 questions, and its range is from 0 to 72.

5.3.3.3 Behavioral Inhibition System (BIS) and Behavioral Activation System (BAS)

This questionnaire is based on Gray's biopsychological theory of personality, brain functions and behavior (Gray, 1981). Namely, there are two important neural systems regulating behavior, the appetitive and the aversive motivational system, which Gray calls the behavioral activation/approach system (BAS), and the behavioral inhibition system (BIS) (Carver & White, 1994). People with a sensitive BIS system are more sensitive to punishment, more likely to feel anxiety, and to avoid behaviors that might put one in

danger. On the other hand, people with a sensitive BAS system are more sensitive to rewards, more likely to feel joy, and to engage with the environment in order to pursue goals. The BAS has been shown to have three components. Reward Responsiveness (BAS-RR) refers to responding highly positive to rewards or anticipation of rewards, Fun Seeking (BAS-FS) refers to the desire to find new rewards, and Drive (BAS-D) refers to the persistence in the pursuit of goals. Furthermore, Grey states that the BIS and the BAS are orthogonal because different neural structures seem to underlie this system (Gray, 1987). Independence of these two traits was also empirically established (Carver & White, 1994).

If the SMT measures approach and avoidance behavior, it can be expected that individual differences on BIS and BAS systematically affect the overall tendency to give approach/avoidance responses, i.e. press 'up' or 'down'. Furthermore, just like the anxiety sensitivity, the responses to this questionnaire could also give us insights into the relevance of the stimuli for different persons. We could expect that for the people who score higher on BAS, and thus are more sensitive to rewarding stimuli, the positive stimuli would be more salient than for the people scoring lower on BAS. Conversely, the individuals scoring higher on the BIS, and thus more sensitive to non-rewards, could find negative stimuli more salient from the ones who score low on BIS. Furthermore, although it is possible to combine the three BAS scores in one general score, the authors of the scale recommend using the sub-scores separately (Carver & White, 1994). For this reason, in addition to the total BAS score, we decided to separately use the BAS-RR sub-scale in the analyses. The reason for choosing to focus this sub-scale is that it directly reflects the high responsiveness to positive stimuli, such as ones we were presenting, while the BAS-FS refers to active seeking of new rewards, and the BAS-D tells more about persistence in attaining goals than the momentary responsiveness to positive stimulation.

A German translation of the questionnaire developed by Carver and White was used in this study (Carver & White, 1994; Strobel et al., 2001). It has 24 items, 7 of which belong to the BIS scale (e.g. "Criticism or scolding hurts me quite a bit"), 5 to the BAS-RR (e.g. "When I am doing well at something I love to keep at it"), 4 to the BAS-D (e.g. "When I want something I usually go all-out to get it"), and 4 to the BAS-FS (e.g. "I will often do things for no other reason than that they might be fun") (Strobel et al., 2001). The answer to the items is given on a 4-point scale (1 - "very false for me ", 2 - "somewhat false for me ", 3 - "somewhat true for me ", 4 - "very true for me"). The BIS score is calculated by adding up the answers to the 7 statements, and its score ranges from 7 to 28. The BAS-RR score is built from 5 statements, its score ranging from 5 to 20. The scores on the BAS-D and the BAS-FS contain 4 items each and their scores range from 4 to 16. Three of the questions are fillers.

5.3.3.4 Feedback questions

At the end of experiment, participants gave their feedback on the Size Modification Task and the Similarity Induction Task in two questionnaires. Regarding the SMT, the questionnaire consisted of ten

statements with 7-point Likert scale on which participants indicated the level to which they agree (- 3 - "not at all" to +3 – "very much"). Half of the statements referred to reasons behind clicking 'up' (e.g. 'I pressed the UP button to help me enjoy pictures I liked'³). The purpose of these statements was to check whether the participants wanted to increase the picture size because of the positive feelings the pictures elicited (liking, joy, interest) as we expected, or rather because the pictures were complex and hard to interpret. Another half referred to reasons behind clicking 'down' (e.g. 'I pressed the DOWN button to help me avoid looking at pictures I disliked'⁴). These statements were to assess whether the participants wanted do decrease the size of the picture because of the negative feelings these pictures elicited (disliking and negative arousing emotions) as we expected, or rather because they were uninteresting or hard to interpret. The answers to statements about both clicking 'up' and 'down' were used to identify the participants who reported that they did not approach and avoid stimuli for the reasons we expected. These participants were to be omitted from the analysis, since we could not claim that in their cases the task measured what the SMT was expected to measure, that is approach to positive and avoidance of neutral stimulation.

In the second questionnaire participants were asked to guess the aim of the study, and to indicate whether the set-up felt artificial to them, and might have led them to doubt the realness of the interaction. Participants were excluded from the study if they guessed the real aim of the study, and if they were convinced that the answers from other participants in the SIT were not real.

5.4 Experimental procedure

The participants who met the criteria for the following week of testing (see Chapter 5.1.), were invited to apply for the study via email. The additional precondition was that participants in the same group meet each other for the first time. Participants were informed about this rule via email prior to applying, and it was additionally checked before the start of the experiment. The real aim of the study was not revealed to participants, but they were told that the study was about the relation between the ability appraise others and the preferences for image size. Overall, the experiment took between 55 and 60 minutes.

The experiment was done in a spacious room with computers enclosed in cubicles, which did not allow the visual contact between the participants. Before the beginning of the experiment, they were informed that they are not allowed to communicate with each other during the experiment. It was stressed that they would be connected online during the group task. Participants read and signed the informed consent forms and the payment forms (circa 10 min). After that, they completed the two questionnaires - the ASI-3 and the BIS/BAS (5-10 min). Then, they did the first version of the SMT (8 min). The instructions for the task were delivered on screen, and participants could additionally ask questions before starting.

³ "Ich habe die OBERE Pfeiltaste gedrückt, um Bilder, die ich mochte, zu genießen".

⁴ "Ich habe die UNTERE Pfeiltaste gedrückt, um es zu vermeiden Bilder anzusehen, die ich nicht mochte".

There were 4 test trials with neutral social and non-social pictures, which were followed by 60 trials. After the first run of the task, participants filled out the PANAS (2-3 min). Then, the SIT started at the same time for everyone (10 min). The participants in the same group always had the same condition – either similarity or dissimilarity. Immediately after the task, they filled in the affiliation and interpersonal closeness scale. The second run of the SMT followed (8 min). The instructions were repeated, but this time there were no test trials. The PANAS was administered for the second time immediately after the second run of the SMT (2-3 min). The experiment was finished with filling out the feedback questionnaires (circa 5 min).

5.5 Data Analysis

The data analysis process had several phases. First, the answers on the feedback questions were used to identify the participants who guessed the real aim of the study and/or did not believe that the answers of others in the SIT were real. If the written answers suggested that participants were convinced that the answers of others were automatically generated, i.e. did not come from the other participants in the room, they were excluded from the study, as well as if they understood that the point of the SIT was to induce social closeness. Furthermore, if participants reported that they did *not* approach the positive stimuli in the SMT because of the liking of or positive emotion elicited by the stimuli, and that they did *not* avoid negative stimuli in the SMT because of disliking of or negative emotions elicited by the stimuli, they were also to be excluded from the analysis.

Second, the experimental manipulation was checked using the affiliation and interpersonal closeness measure and the sameness measure. *The social closeness measure* is the average value of answers to the questions belonging to the affiliation and interpersonal closeness scale that showed significant intercorrelations. *The sameness measure* is a nominal measure based on the additional 4 SIT items. The participants first estimated the others' answers and then gave their own answers on each of these items. If all 4 answers matched between one's own answer and their estimation of what others answered, the sameness measure would be 4, and if there were no matching answers, the sameness measure would be 0. An independent-samples t-test was used to check the difference between the similarity and the dissimilarity group on these two measures of closeness.

After the manipulation check, the measures from the SMT were pre-processed. Before the preprocessing, each participant had four values for each trial of each stimulus category, pre and post manipulation: the number of approach responses (clicks 'up'), the number of avoidance responses (clicks 'down'), the speed of clicking (number of clicks per second between the first and the last click in a trial) during approach and avoidance responses, and the difference between approach and avoidance responses, which directly corresponds to the image size (the number of clicks 'up' – the number of clicks 'down'). Furthermore, for all measures except for image size, trials belonging to the positive conditions that contained avoidance responses were discarded, and likewise, trials belonging to the negative conditions that contained approach responses were discarded. For the neutral condition no trials were omitted. Participants who had all trials of one stimulus category excluded through this procedure were excluded from the analysis of the number of and speed of approach/avoidance responses. The result was that all positive trials had the number and speed only of approach clicks, and all negative trials had the number and speed only of approach clicks, and all negative trials had the number and speed only of non-congruent responses was done because approach behavior towards positive stimuli and avoidance behavior towards negative stimuli were the behaviors central to our hypotheses. However, since the participants sometimes also avoided positive and approached negative stimuli, these incongruent responses remained in the analyses of the image size, the final product of all clicks in each trial.

For each participant, the mean number and speed of approach responses to positive and neutral stimulus categories, the mean number and speed of avoidance responses to negative and neutral stimulus categories, and the average image size for all stimulus categories were calculated, separately for the task before and the task after the experimental manipulation (pre-SIT and post-SIT).

Winsorization was performed on these mean approach/avoidance measures for each stimulus category for the similarity and the dissimilarity group separately, in order to correct for outlier responses. The values above the upper quartile added to the 1.5 times the interquartile range, and below the lower quartile added to the 1.5 times the interquartile range were replaced by the larger or the smallest remaining values.

In order to check whether groups differed in the approach/avoidance measures before the experimental manipulation, two mixed ANOVAs were performed on the number and speed of approach/avoidance responses before the SIT. These models will be referred to as the **baseline approach** and the **baseline avoidance** model. The baseline approach model is $2 \times 2 \times 2$ mixed ANOVA with one between-subjects factor of group (similarity and dissimilarity) and two within-subject factors: sociality (social and non-social) and valence (positive and neutral). It was performed separately on the number and the speed of *approach* responses. The baseline avoidance model is also $2 \times 2 \times 2$ mixed ANOVA with one between-subjects factor (group) and two within-subject factors: sociality (social and non-social) and valence (negative and neutral). This model was performed both on the number and the speed of *avoidance* responses. When it comes to the image size measure, since it contained both approach and avoidance responses towards all stimuli, it had only one baseline model. The **baseline model on the image size** was $2 \times 2 \times 3$ mixed ANOVA, with one between-subjects factor (group) and two within-subject factors: sociality (social and non-social) and valence (positive, neutral and negative).

From the analyses on the baseline model, conclusions were drawn on the effectiveness of each approach/avoidance measure. Each measure needed to differentiate between the emotional (positive,

negative) and the neutral stimuli in order for the hypotheses to be tested on that dependent variable, meaning that positive stimuli needed to consistently elicit more approach behavior than neutral, and that negative stimuli needed to consistently elicit more avoidance behavior than neutral. This needed to be shown both for social and non-social stimuli. As it is reported in Chapter 6.2.2, the speed measure did not fully meet this pre-condition, therefore, it was excluded from the subsequent analyses.

After the baseline check, four mixed ANOVAs were performed to test the hypotheses 1 and 2 on the two approach/avoidance measures separately: the number of approach/avoidance responses and the image size measure. The social approach model was 2 x 2 x 2 mixed ANOVA with a between-subjects factor of group (similarity, dissimilarity), and two within-subjects factors: valence (positive, neutral) and pre-post (pre-SIT, post-SIT). This model addressed hypothesis 1a. The social avoidance model was 2 x 2 x 2 mixed ANOVA including a between-subjects factor of group (similarity, dissimilarity), and two withinsubjects factors: valence (negative, neutral) and pre-post (pre-SIT, post-SIT). It addressed the hypothesis 1b. Accordingly, the other two models were performed on the non-social trials to address the hypotheses 2a and 2b: the non-social approach model had 2 x 2 x 2 design with one between-subjects factor of group (similarity, dissimilarity) and two within-subjects factors valence (positive, neutral) and pre-post (pre-SIT, post-SIT), and the non-social avoidance model also had 2 x 2 x 2 design with one between-subjects factor of group (similarity, dissimilarity) and two within-subjects factors valence (negative, neutral) and pre-post (pre-SIT, post-SIT). For each model, we were especially interested whether there were interactions between valence, pre-post and group, because that would show that the responses changed after the experimental manipulation depending on whether participants received similarity or dissimilarity induction, and that these responses changed differently for neutral and emotional (positive or negative) stimuli. However, we were also interested in interactions between pre-post and group factor alone, which would mean that the responses changed differently depending on the SIT condition, but irrespective of the valence factor.

After the hypotheses on the entire sample were addressed, median splits were performed on the main ASI score and its sub-score ASI-Cog, the main BAS score and its sub-score BAS-RR, and on the BIS score. The following analyses were performed on the participants above the median on these scales and sub-scales. Participants who had scores equal to median on a certain trait or a sub-trait were excluded from the analyses on that trait or a sub-trait. It is important to mention that the analyses addressing the hypotheses 3 and 4 were performed on less than a half of the total sample (depending on how many participants were omitted due to scoring equal to median). A bigger sample would be needed to more adequately address these hypotheses.

In order to address *hypotheses 3*, the above-mentioned four models (social approach, social avoidance, non-social approach and non-social avoidance) were performed on the approach/avoidance measures only in the participants above the median on the anxiety sensitivity index (ASI). Apart from the

main ASI score, the models were also performed on the participants above the median in the cognitive subscale of anxiety sensitivity (ASI-Cog). The reason for separately including ASI-Cog is that Harari-Dahan and Bernstein showed the effects of oxytocin only on the participants high on this sub-scale of anxiety sensitivity (Harari-Dahan & Bernstein, 2017) (see Chapter 3.3 and 5.3.3). Because the analyses on two related measures were performed (ASI-Cog being a part of the total ASI score), the Bonferroni correction of p values in all the analyses addressing the hypothesis 3 were performed.

Regarding the *hypothesis 4a*, the four models (social approach, social avoidance, non-social approach and non-social avoidance) on the approach/avoidance measures were performed in the participants above the median on the BAS score. In addition to the main BAS score, the models were also separately performed for the participants above the median on the Reward Responsivity sub-scale of BAS (BAS-RR). As stated in Chapters 3.3 and 5.3.3, the reason for additionally focusing on this sub-scale is that the BAS-RR is most relevant for the behavior in our approach/avoidance task among the BAS sub-scales, and also because BAS is not a completely coherent structure and it is not necessarily recommended to aggregate the scores from the three sub-scales (Carver & White, 1994). Just like in case of hypothesis 3, p values obtained in all analyses addressing hypothesis 4a were Bonferroni-corrected, because the BAS-RR is contained in the total BAS, thus these two measures are related.

In order to address the *hypothesis 4b*, the four models (social approach, social avoidance, non-social approach and non-social avoidance) on the approach/avoidance measures were performed only in the participants above the BIS median. Just like in the main models, the effects of interest were: the interactions between valence, time and group and/or the interactions between time and group.

After the main hypotheses were tested, several exploratory analyses were performed. The first group of exploratory analyses addressed the additional effects of experimental manipulation. As an additional way to test whether social closeness affected the approach/avoidance behavior, the two social closeness measures were correlated with the differential values between the pre-SIT and the post-SIT approach/avoidance measures for each of the 6 stimulus categories. Secondly, we were also interested whether the reports of positive and negative affect changed after the SIT differently depending on whether participants went through the similarity or the dissimilarity induction. Two 2 x 2 ANOVAs were performed, each with a between-subjects factor of group (similarity, dissimilarity) and a within-subjects factor pre-post (pre-SIT, post-SIT), separately for the positive and the negative affect score on the PANAS.

The second group of exploratory analyses addressed the relation between personal traits and the approach/avoidance measures. We were interested in whether the general tendency to approach or avoid the stimuli would be related to individual scores on the total ASI and its sub-scale ASI-Cog, BAS and its sub-scale BAS-RR, and BIS. Participants sensitive to anxiety (ASI) and unpleasant sensations in general (BIS) could be expected to be more prone to avoiding negative content, and participant sensitive to rewards

(BAS) could be expected to be more prone to approaching positive content. If the Size Modification Task indeed measured approach towards positive and avoidance of negative stimuli, these personal traits are expected to be related to the approach/avoidance measures.

In order to explore this, the scores on each personality trait were correlated with the average approach/avoidance measures for each of the 6 stimulus categories. Moreover, the median split of each trait score was included separately as a between-subject factor in four 2 x 2 mixed ANOVAs, corresponding to the four models previously used: social approach, social avoidance, non-social approach, and non-social avoidance. These models had the same structure as the above explained main models of the same names, but the pre-post factor was not included, and instead of group, median split on a trait was a between subject factor. Since ASI-Cog is a sub-scale of ASI, and since BAS-RR is a sub-scale of BAS, all statistics obtained in the analyses with these four variables were corrected for multiple testing (Bonferroni correction).

6 Results

6.1 Experimental manipulation check

6.1.1 Exclusion of participants and trials

The sample originally consisted of 62 participants. Three participants were excluded from the analysis based on their answers on the feedback questions, because they did not trust that the other SIT answers really came from the participants in the room, and suspected that they were generated by computer. The data of the remaining 59 participants was used in the analysis of the image size measure (29 in the similarity and 30 in the dissimilarity group) and in the experimental manipulation check. However, three more participants were excluded from the analysis of the number of approach/avoidance responses and the speed of approach/avoidance clicking, because after discarding trails with mixed approach/avoidance clicks, they had no remaining responses on these measures for one or more stimulus categories. Therefore, the analysis of the number of approach/avoidance clicking was performed on 56 participants (28 in the similarity and 28 in the dissimilarity group). No participants were excluded due to the answers on the SMT feedback questionnaire. Finally, in the pre-processing of the SMT data, around 16% of the overall number of the trial responses were discarded due to the exclusion criteria stated in Chapter 5.5.

6.1.2 Social closeness measures

The affiliation and interpersonal closeness measure consisted of 6 questions and the IOS scale (see Chapter 5.3.1.). The responses to 5 questions and the IOS showed significant inter-correlations, ranged from r(59) = .31, p = .016, to r(59) = .73, p < .0001. The question referring to how well one got to know

other participants did not correlate to the other questions and, therefore, was excluded from the aggregate social closeness measure. The sameness measure, indicating the degree to which participants selected similar responses for the group members in the last part of the SIT, was analyzed separately.

The independent-samples t-test showed that the social closeness ratings differed highly significantly between the similarity and the dissimilarity group (T(57) = 10.181, p < .0001). Similarity group reported higher social closeness (M = 1.06, SD = .8) than the dissimilarity group (M = -.92, SD = .69). Theoretical maximum on this measure was 3 and minimum -3. The difference between groups on the sameness measure was not significant, although a trend of higher sameness measure in the similarity group (M = 2.07, SD = .92) than in the dissimilarity group (M = 1.57, SD = .92) could be observed (T(57) = 1.96, p = .055). Theoretical maximum of the sameness measure was 4, and minimum 0. Based on these results, it can be concluded that the individuals in the similarity group, but that the average ratings were generally closer to the middle than to the ends of the scales.

6.2 Baseline models

6.2.1 Number of approach/avoidance responses

6.2.1.1 Baseline approach

This was a 2 x 2 x 2 mixed ANOVA with one between-subjects factor of group (similarity, dissimilarity) and two within-subjects factors: sociality (social, non-social) and valence (positive, neutral), performed on the number of approach responses collected before the social closeness manipulation. Significant interactions were explored using post hoc t tests with Bonferroni corrections of p values.

The main effects of sociality (F(1) = 30.19, p < .0001, $\eta_p^2 = .36$) showed that there were more approach responses towards non-social (M = 7.48, SD = 3.31) than social stimuli (M = 5.35, SD = 3.17). This effect replicates the finding from the pilot study, which also showed higher approach towards nonsocial than social stimuli (Appendix 1). The main effect of valence (F(1) = 291.21, p < .0001, $\eta_p^2 = .84$) showed that participants had more approach responses towards positive (M = 9.22, SD = 4.08) then neutral stimuli (M = 3.61, SD = 2.4). This effect implies that our approach/avoidance task elicited more approach towards positive than towards neutral stimuli, which indicates that the number of approach responses successfully differentiated positive and neutral conditions.

Interaction between valence and group was found (F(1) = 5.08, p = .028, η_p^2 = .09). Post hoc tests showed that the similarity group had more approach responses towards positive stimuli (M = 9.91, SD = 3.38) than the dissimilarity group (M = 8.54, SD = 3.16) (*T*(54) = 1.567, p = .246). The number of approach responses towards neutral stimuli, on the other hand, did not differ between groups (*T*(54) = -.197, p = 1).

This interaction indicated that there was a baseline difference between groups in the number of approach responses towards positive stimuli in particular.

Furthermore, significant interaction between sociality and valence was found (F(1) = 40.75, p < .0001, η_p^2 = .43). Post hoc tests indicated that non-social positive stimuli had more approach responses (M = 11.31, SD = 4.21) than social positive stimuli (M = 7.14, SD = 3.96) (*T*(55) = -6.542, p < .0001), while there was no difference in the number of approach responses towards neutral social (M = 3.57, SD = 2.38) and non-social stimuli (M = 3.65, SD = 2.41) (*T*(54) = -.251, p = 1). This interaction shows that non-social positive stimuli elicited a higher number of approach responses than social positive stimuli, but also indicates that the difference between the number of positive and neutral approach responses was larger for non-social stimuli than for social stimuli.

6.2.1.2 Baseline avoidance

Baseline avoidance model was a 2 x 2 x 2 ANOVA with one between-subjects factor of group (similarity, dissimilarity) and two within-subjects factors: sociality (social, non-social) and valence (negative, neutral), performed on the number of avoidance responses before the social closeness induction. Post hoc analyses of the significant interactions consisted of t tests with Bonferroni corrections of p values.

This model showed the main effect of sociality (F(1) = 18.36, p < .0001, η_p^2 = .25), as the number avoidance responses was higher for non-social (M = 6.97, SD = 3.11) than for social stimuli (M = 5.79, SD = 2.98). Furthermore, strong main effect of valence was shown (F(1) = 440.08, p < .0001, η_p^2 = .89), as negative stimuli (M = 10.56, SD = 3.91) had more avoidance responses than neutral (M = 2.2, SD = 2.18). This effect shows that negative emotional stimuli in the approach/avoidance task elicited more avoidance than neutral stimuli, meaning that this measure of avoidance behavior successfully differentiated negative and neutral stimuli. In this model, the main effect of group was also found (F(1) = 4.52, p = .038, η_p^2 = .08), as the similarity group (M = 7.04, SD = 3.56) had generally more avoidance responses than the dissimilarity group (M = 5.71, SD = 2.55). This indicates that individuals in the similarity group generally avoided negative and neutral stimuli more before the social closeness induction was conducted.

The interaction between sociality and valence was also found on the number of avoidance responses $(F(1) = 29.56, p < .0001, \eta_p^2 = .35)$. Post-hoc tests showed that, while non-social negative stimuli had more avoidance responses (M = 11.83, SD = 4.17) than social negative stimuli (M = 9.29, SD = 3.65) (T(55) = -5.47, p < .0001), there was no difference between the number of avoidance responses towards non-social and social neutral stimuli (T(55) = .67, p = 1). This interaction implies that non-social stimuli were avoided more than social stimuli only in the negative and not neutral condition, which also indicated that difference between negative and neutral avoidance was higher for non-social than for social stimuli.

Baseline models performed on the number of approach/avoidance responses primarily showed that the emotional stimuli elicited more responses (positive approach and negative avoidance) than the neutral stimuli, which was the case both for social and non-social stimuli. Thus, this measure of approach/avoidance behavior differentiates well between avoidance of negative and avoidance of neutral, and between approach to positive and approach to neutral stimuli. This differentiation is successful both for social and non-social stimuli, but is more pronounced in case of non-social stimuli. Finally, although the differences between groups before the experimental manipulation were not expected, on a baseline level the similarity group performed more approach responses to positive and more avoidance responses to negative and neutral stimuli compared to the dissimilarity group.

6.2.2 Speed of approach/avoidance responses

6.2.2.1 Baseline approach

The 2 x 2 x 2 ANOVA performed on the speed of approach responses had the same design as the baseline approach model of the number of approach responses. Directions of a significant interaction was explored using post-hoc t-tests with Bonferroni-corrected p values.

The main effect of sociality was found in the model performed on the speed of approach clicking $(F(1) = 4.12, p = .047, \eta_p^2 = .07)$, showing that participants approached non-social stimuli faster (M = 4.2, SD = 1.37) than social stimuli (M = 3.97, SD = 1.44). This effect indicated that the difference between social and non-social stimuli does not exist only for the number, but also the speed of approach clicking. The main effect of valence was also found (F(1) = 21.313, p < .0001, η_p^2 = .28), indicating that participants approached positive stimuli (M = 4.44, SD = 1.32) faster than the neutral stimuli (M = 3.73, SD = 1.48), which shows that speed measure generally differentiated positive and neutral stimuli.

In this model an interaction between sociality and valence was found (F(1) = 25.4, p < .0001, η_p^2 = .32). Post hoc tests showed that, while the approach towards positive non-social stimuli (M = 4.89, SD = 1.11) was faster than towards neutral non-social stimuli (M = 3.51, SD = 1.64) (*T*(54) = 6.89, p < .0001), for social stimuli there was no difference between the speed of approach towards positive (M = 3.99, SD = 1.54) and neutral stimuli (M = 3.95, SD = 1.32) (*T*(54) = .204, p = 1). Approach towards positive stimuli was faster than approach towards neutral stimuli only in the non-social conditions, while the speed of approach towards positive and neutral stimuli did not differ in the social conditions.

6.2.2.2 Baseline avoidance

The 2 x 2 x 2 ANOVA performed on the speed of avoidance responses had the same factorial structure as the model performed on the number of avoidance responses, and was also followed by posthoc t-tests.

The main effect of valence was shown (F(1) = 25.21, p < .0001, η_p^2 = .31), as speed of avoidance was higher for negative (M = 4.52, SD = 1.36) than neutral stimuli (M = 3.73, SD = 1.48), which is also consistent with expectations from the approach/avoidance task. Furthermore, an interaction between

sociality and valence was found (F(1) = 17.94, p < .0001, η_p^2 = .25). Post hoc tests on this interaction showed that the speed of avoidance was significantly higher for negative non-social (M = 4.76, SD = 1.08), compared to neutral non-social stimuli (M = 3.51, SD = 1.64) (*T*(55) = 5.89, p < .0001). However, the speed of avoidance responses did not significantly differ between negative social (M = 4.29, SD = 1.21) and neutral social stimuli (M = 3.95, SD = 1.33) (*T*(55) = 2.08, p = .084), even though a trend in the expected direction is observed. Similar to what was found in the approach model, the speed of avoidance is higher for negative than for neutral stimuli only in the non-social conditions, while social negative and neutral did not significantly differ in the speed of avoidance.

6.2.2.3 Exclusion of the speed measure

Reported models suggest that, in general, the approach to positive stimuli was faster than approach to neutral stimuli, and avoidance of negative stimuli was faster than avoidance of neutral stimuli. However, the interactions between sociality and valence imply that these main effects are mostly due to the differences found in non-social conditions, while social conditions showed no difference in the speed of clicking between emotional (positive and negative) and neutral stimuli. The speed measure was included with expectation that it would minimize the differences between social and non-social conditions. Although the sociality effect did not occur in the avoidance model, the main effect of sociality on the number of approach responses was reproduced on the speed of approach responses, showing that non-social stimuli elicit faster approach clicking than social stimuli. Moreover, both baseline models on the speed of clicking showed that the speed measure does not successfully differentiate between emotional (positive and negative) and neutral social stimuli. These findings suggest that the speed measure does not compensate for the weak points of the number of clicks measure, but in the contrary, has additional disadvantages. For this reason, we decided this measure is redundant and that it would not be used in the subsequent analyses.

6.2.3 Image size

Baseline model performed on the image size was a 2 x 2 x 3 mixed ANOVA with one betweensubjects factor of group (similarity, dissimilarity) and two within-subject factors: sociality (social and nonsocial) and valence (positive, neutral and negative). Interactions were explored using post-hoc t-tests with Bonferroni-corrections of p values.

The main effect of sociality on image size (F(1) = 7.63, p = .008, η_p^2 = .12) indicated that sizes of non-social stimuli (M = .53, SD = 4.4) were overall larger than sizes of social stimuli (M = -.7, SD = 4.45), irrespective of valence. The main effect of valence on image size was also found (F(1.55) = 293.7, p < .0001, η_p^2 = .84). Pairwise comparisons show that the differences between all three valence levels (positive (M = 6.21, SD = 4.84), neutral (M = 1.08, SD = 3.24) and negative (M = -7.54, SD = 5.18)) are significant on levels of p < .0001 (Bonferroni-corrected), as positive stimuli were larger than neutral and negative, and

neutral stimuli were larger than negative. This finding is in line with what was shown on the number of approach/avoidance responses and confirms that participants increased the size of positive and decreased the size of negative stimuli as expected.

Interaction was found between valence and group (F(1.55) = 4.93, p = .015, $\eta_p^2 = .08$). The difference between the similarity and the dissimilarity group was significant only for size of negative stimuli (T(57) = -2.7, p = .027), as the similarity group made negative images smaller (M = -9.69, SD = 3.97) than the dissimilarity group (M = -6.59, SD = 4.81). Participants from the similarity group decreased size of negative images more than participants from the dissimilarity group, while there were no differences in the size of neutral (T(57) = -1, p = .96) and positive stimuli (T(57) = 1, p = .96) between groups.

Also, there was an effect of interaction between sociality and valence on image size (F(1.55) = 36.68, p < .0001, $\eta_p^2 = .39$). Post hoc tests showed that non-social positive stimuli (M = 8.96, SD = 4.72) were larger than social positive stimuli (M = 3.46, SD = 4.97) (T(58) = -6.42, p < .0001), and that non-social negative stimuli (M = -8.55, SD = 5.73) were smaller than social negative stimuli (M = -6.53, SD = 4.64) (T(58) = 3.05, p = .009), while there was no difference in size between social and non-social neutral stimuli (T(58) = -.49, p = 1). In line with the findings on the number of clicks, this result shows that participants increased positive non-social stimuli more than positive social, and decreased negative non-social stimuli more than negative social, and also that the non-social stimuli show higher differentiation of the image size between different valence levels.

6.3 Effects of social closeness on approach/avoidance measures

6.3.1 The social approach model

This model was a 2 x 2 x 2 ANOVA with between-subject factor of group (similarity, dissimilarity), and within-subjects factors: valence (positive, neutral) and pre-post (pre-SIT, post-SIT), performed on the number of approach responses and on the image size. Interactions were explored with Bonferroni post-hoc tests.

We found a strong main effects of valence on the number of approach responses (F(1) = 117.57, p < .0001, η_p^2 = .69) (Figure 4) and on image size (F(1) = 52.26, p < .0001, η_p^2 = .48). These effects showed that the number of approach clicks was higher for positive (M = 6.98, SD = 3.81) than neutral social stimuli (M = 3.2, SD = 2.34), and accordingly, the size of the positive social stimuli was bigger (M = 3.58, SD = 4.61) than the size of the neutral social stimuli (M = .69, SD = 3.48). This result confirms that our task elicited more approach behavior towards positive than neutral social stimuli. Furthermore, a trend towards the main pre-post effect on the number of approach responses was found (F(1) = 2.88, p = .096, η_p^2 = .05), showing that the number of approach responses generally decreased through time for both positive and

neutral social stimuli and in both groups (pre-SIT: M = 5.35, SD = 3.17; post-SIT: M = 4.87, SD = 2.98) However, this trend was not shown on the image size measure.

Significant interactions between the valence and the group were found both on the number of approach responses (F(1) = 6.14, p = .016, η_p^2 = .1) and on the image size (F(1) = 5.3, p = .025, η_p^2 = .09), Post hoc t-tests showed that the similarity group had somewhat higher number of the approach responses towards positive social stimuli (M = 7.68, SD = 3.63) than the dissimilarity group (M = 6.29, SD = 3.06) (*T*(54) = 1.54, p = .258), while there was no difference between the groups in the number of approach responses towards neutral social stimuli (*T*(54) = -.57, p = .1). When it comes to the interaction on the image size measure, size of positive social stimuli was insignificantly higher in the similarity (M=4.07, SD=4.17) than in the dissimilarity group (M = 3.1, SD = 4.3) (*T*(54) = .877, p = .76), and size of neutral social stimuli was insignificantly lower in the similarity (M = .24, SD = 3.2) than in the dissimilarity group (M = 1.1, SD = 2.9) (*T*(54) = -1.11, p = .55). Just like in the baseline model, participants in the similarity group, while groups did not differ in approach responses towards neutral social stimuli differed insignificantly between groups (consistent with the baseline model on the image size), but in the opposite directions, which caused a significant interaction.

As there were no significant interactions between group and pre-post, it can be concluded that the social closeness induction did not increase the number of the approach responses towards positive social stimuli, neither it increased the speed of approach and the image size. The hypothesis 1a was thus not confirmed.

6.3.2 The social avoidance model

This model was 2 x 2 x 2 ANOVA with between-subject factor of group (similarity, dissimilarity), and within-subjects factors: valence (negative, neutral) and pre-post (pre-SIT, post-SIT), performed on the number of avoidance responses and the image size. Bonferroni post-hoc tests were performed in order to explore a significant interaction.

Main effect of valence was shown both on the number of avoidance responses (F(1) = 249.043, p = .000, η_p^2 = .845) (Figure 4) and on the image size (F(1) = 173.71, p < .0001, η_p^2 = .75). Number of avoidance responses was higher for negative (M = 9.70, SD = 4.18), compared to neutral social stimuli (M = 2.24, SD = 2.26). Consistently, the image size was smaller for negative (M = -6.71, SD = 5.31) than neutral social stimuli (M = 0.69, SD = 3.48). Only the model performed on the image size showed two additional effects: the main group effect (F(1) = 50.53, p = .014, η_p^2 = .1) and the interaction between the valence and group (F(1) = 5.1, p = .028, η_p^2 = .08). The main group effect shows that the similarity group made negative and neutral social stimuli smaller (M = -4.10, SD = 4.13) than the dissimilarity group (M =

-1.95, SD = 4.35). The interaction between valence and group shows that group difference was more pronounced for the negative social stimuli (T(57)= -2.85, p = .012), as the similarity group made negative social stimuli (M = -8.45, SD = 3.99) smaller than the dissimilarity group (M = -5.02, SD= 5.16), while group difference was not significant for the neutral social stimuli (T(57) = -1.11, p = .54). This is in line with the interaction between the valence and the group found on the image size baseline model, which showed bigger difference between groups for the negative social stimuli with respect to neutral.

The social avoidance models performed on the two approach/avoidance measures also did not yield any interactions that included both pre-post and group. Thus there was no effect of the social closeness induction on the avoidance behavior towards negative social stimuli. Therefore, it can be concluded that the hypothesis 1b was also not confirmed.

6.3.3 The non-social approach model

In order to test the effects of social closeness on non-social approach, a 2 x 2 x 2 ANOVA with between-subject factor of group (similarity, dissimilarity), and within-subjects factors: valence (positive, neutral) and pre-post (pre-SIT, post-SIT), performed on the number of approach responses and the image size. Interactions were additionally analysed with Bonferroni post-hoc tests.

There was a significant effect of valence on both the number of approach responses (F(1) = 308.09, p < .0001, $\eta_p^2 = .851$) (Figure 4) and the image size (F(1) = 226.55, p < .0001, $\eta_p^2 = .8$). Participants had higher number of the approach responses for positive non-social stimuli (M = 11.46, SD = 4.27), compared to neutral non-social stimuli (M = 3.67, SD = 2.56), and bigger image size for positive (M = 9.44, SD = 4.67) than neutral non-social stimuli (M = 1.25, SD = 2.85). A trend towards the main pre-post effect on the image size (F(1) = 3.49, p = .067, η_p^2 = .06) shows that the image size of positive and neutral non-social stimuli was somewhat increased after the SIT in both groups (pre-SIT: M = 5.08, SD = 3.73; post-SIT: M = 5.62, SD = 3.79).

The effects of valence and pre-post on the image size showed a trend towards interaction (F(1) = 3.25, p = .077, η_p^2 = .05). Post-hoc comparisons suggest that size of positive non-social stimuli increased from pre-SIT (M = 8.96, SD = 4.72) to post-SIT (M = 9.93, SD = 4.63) (*T*(58) = -2.38, p = .04), while the size of neutral non-social stimuli did not change over time (*T*(58) = -.33, p = 1).

In the non-social models performed on the two approach/avoidance measures, there were no significant interactions including both pre-post and group. This means that the social closeness induction did not affect the approach behavior towards non-social positive stimuli and, therefore, the hypothesis 2a was also not confirmed.



Figure 4. Main effects of valence on the number of approach/avoidance responses in the main four models

6.3.4 The non-social avoidance model

The effects of social closeness on non-social avoidance were tested using a 2 x 2 x 2 ANOVA with between-subject factor of group (similarity, dissimilarity), and within-subjects factors: valence (negative, neutral) and pre-post (pre-SIT, post-SIT), performed on the number of avoidance responses and the image size. Bonferroni post hoc tests were used in the further analyses of interactions.

The main effects of the valence were shown on both the number of avoidance responses (F(1) = 474.33, p < .0001, η_p^2 = .9) (Figure 4) and the image size (F(1) = 226.45, p < .0001, η_p^2 = .8). Negative non-social stimuli had a higher number of avoidance responses (M = 12.53, SD = 4.19) than neutral non-social stimuli (M = 2.09, SD = 1.88), and a smaller image size (M = -9.52, SD = 5.62) than neutral non-social stimuli (M = 1.25, SD = 2.85). Also, we found the main effects of pre-post both on the number of avoidance responses (F(1) = 8.25, p = .006, η_p^2 = .13) and the image size (F(1) = 6.88, p = .011, η_p^2 = .11). Between the two time-points, there was a general increase in the number of avoidance responses (pre-SIT: M = 6.97, SD = 3.11); post-SIT: M = 7.65, SD = 2.95) and a general decrease in the image size, (pre-SIT: M = -3.68, SD = 4.24; post-SIT: M = -4.59, SD = 4.24) for all stimuli and in both groups. Furthermore, the main effect of group was shown on the number of avoidance responses (F(1) = 4.55, p = .038, η_p^2 = .08) and on the

image size (F(1) = 4.2, p = .045, η_p^2 = .07). The number of avoidance responses was higher, and correspondingly, the image sizes were smaller in the similarity (M = 7.97, SD = 3.16) than in the dissimilarity group (M = 6.65, SD = 2.75), which reflects the group baseline difference discussed before.

Moreover, we found the effect of interaction between valence and pre-post on the number of avoidance responses (F(1) = 11.21, p = .001, η_p^2 = .17). Post hoc t-tests showed that the increase of avoidance responses to negative stimuli from pre-SIT (M=11.83, SD=4.17) to post-SIT (M=13.24, SD=4.2) was significant (*T*(55) = -3.42, p = .002), while the number of avoidance responses did not change over time for the neutral stimuli (*T*(55) = .3, p = 1). A consistent interaction between valence and pre-post was found on the image size measure (F(1) = 12.73, p = .001, η_p^2 = .18). Size of negative non-social stimuli decreased from pre-SIT (M=-8.55, SD=5.73) to post-SIT (M=-10.49, SD=5.52) (*T*(58) = 3.63, p = .002), while size of neutral non-social stimuli did not change over time (*T*(58) = -.33, p = 1). Taken together, the number of avoidance responses increased over time for negative non-social stimuli in particular (with respect to neutral stimuli), and accordingly, size of negative stimuli decreased over time only for the negative non-social stimuli. Although they refer to change in behavior after the SIT, these effects are not in any way related to the experimental manipulation, since they do not depend on group.

In conclusion, the non-social avoidance models performed on the number of avoidance responses and the image size did not show any interactions with both pre-post and group, meaning that group did not affect the change in avoidance responses over time. This means that the social closeness induction did not decrease the avoidance towards non-social negative stimuli as was expected. Thus it can be concluded that the hypothesis 2b was also not confirmed.

Based on the results reported in this chapter, it can be concluded that hypotheses 1 and 2 were not confirmed, as none of the models showed an effect of the social closeness induction on measures of approach and avoidance behavior.

6.4 Effects of social closeness on approach/avoidance measures in participants with high anxiety sensitivity, BAS and BIS

In order to test whether the social closeness induction specifically affected the participants with high anxiety sensitivity, BAS and BIS, the four main models reported in last chapter (social approach, social avoidance, non-social approach and non-social avoidance) were performed on the number of approach/avoidance responses and the image size separately for participants who scored high on each of these traits (above the median). Additionally, these models were also performed in participants with high

ASI-Cog and BAS-RR scores, as stated in Chapter 5.5. Since ASI-Cog is a sub-scale of ASI, these analyses were dependent, and the same is the case for BAS-RR and BAS. Therefore, p values were corrected for multiple testing (Bonferroni correction) in all analyses performed with ASI, ASI-Cog, BAS and BAS-RR. Models performed on these sub-samples that showed only effects with the same directions as the effects obtained on the entire sample will not be reported in this section, as they do not add new information to already reported results. Instead, the section will focus only on models that showed the effects of similarity induction on approach/avoidance behavior that was not found on the entire sample.

None of the models performed with the participants high in ASI and its sub-scale ASI-Cog showed effect of similarity induction on the number of approach/avoidance responses nor on the image size. Therefore, it can be concluded that similarity induction did not lead to a stronger decrease in avoidance responses towards in participants with high anxiety sensitivity, and this was the case both for social and non-social conditions. Thus hypothesis 3 was not confirmed.

Furthermore, models performed with the participants high in BAS and its sub-scale BAS-RR also showed no effects of similarity induction on the number of approach/avoidance responses nor the image size. Participants high in BAS and BAS-RR of the similarity group did not show stronger increase in the number of approach responses nor the image size compared to the dissimilarity group, and this was the case both for social and non-social conditions. Therefore, hypothesis 4a was also not confirmed.

When it comes to the models performed with participants higher on BIS, *social* approach and avoidance models did not yield any effects of similarity induction on approach/avoidance measures towards social stimuli. However, the models of *non-social* approach and avoidance in participants high on BIS showed the effects relevant for our hypotheses, therefore the chapter will focus on these two models.

6.4.1 The non-social approach model in participants with high BIS

This was a 2 x 2 x 2 ANOVA with a between-subjects factor of group (similarity, dissimilarity) and the within-subjects factors: valence (positive and neutral) and pre-post (pre-SIT, post-SIT) performed on the number of approach responses towards and the image size of non-social stimuli in participants whose BIS score was above the median. Significant interactions were explored with post hoc t-tests with Bonferroni-corrected p values.

The main effect of valence was shown both on the number of approach responses (F(1) = 149.02, p < .0001, $\eta_p^2 = .86$) and on the image size (F(1) = 106.14, p < .0001, $\eta_p^2 = .8$), as positive non-social stimuli had more approach responses (M = 10.84, SD = 4.32) than neutral non-social stimuli (M = 4.14, SD = 2.73) and larger size (M = 8.10, SD = 4.76) than neutral non-social stimuli (M = 1.31, SD = 3.05).



Figure 5. Interaction between valence, pre-post and group found in the non-social approach model in the participants with high BIS

A significant interaction was found between valence and pre-post on the image size measure (F(1) = 5.17, p = .032, $\eta_p^2 = .17$). While the size of positive non-social stimuli increased from pre-SIT (M = 7.37, SD = 4.62) to post-SIT (M = 8.83, SD = 4.89) (T(27) = -2.03, p = .104), the size of neutral non-social stimuli did not change after the SIT (T(27) = -.04, p = 1). Furthermore, a significant interaction was found between valence, pre-post and group (F(1) = 4.72, p = .039, $\eta_p^2 = .15$), displayed on Figure 5. Post hoc tests showed that in the dissimilarity group image size did not change after the SIT, neither for neutral (T(13) = -.03, p = 1) nor for positive non-social stimuli (T(13) = -.11, p = 1). In the similarity group, the size of neutral non-social stimuli also did not change (T(13) = -.03, p = 1), but the size of positive non-social stimuli increased from pre-SIT (M = 6.67, SD = 5.11) to post-SIT (M = 9.5, SD = 5.14) (T(13) = -2.47, p = .112). Importantly, this interaction shows that the size of the positive non-social stimuli was increased after the similarity induction, which was not the case after the dissimilarity induction. This interaction is in line with what was expected to be shown on the entire sample, however, the social closeness effect on the approach behavior was not expected to be stronger in participants high on BIS.





Partially consistent with the above-mentioned interaction, the model performed on the number of approach responses showed a trend towards an interaction between pre-post and group (F(1) = 3.19, p = .087, $\eta_p^2 = .117$), displayed on Figure 6. Number of approach responses towards both positive and neutral non-social stimuli increased from pre-SIT (M = 7.23, SD = 2.75) to post-SIT (M = 8.12, SD = 3.69) in the similarity group (T(13) = -1.66, p = .263), while it somewhat decreased the dissimilarity group (pre-SIT: M = 7.52, SD = 2.9; post-SIT: M = 7.1, SD = 3.85) (T(13) = .84, p = .836). This trend showed that participants who went through similarity condition increased approach to both positive and neutral non-social stimuli, which is partially in line with the expectations we had from the entire sample.

Although this effect and trend are in line with what was expected on entire sample (hypothesis 2a), the hypothesis 4b stated that participants high on BIS would show stronger effect of social closeness on decrease of the *avoidance* behavior. It was not expected that participant high on BIS would show stronger effect of social closeness on the increase of *approach* behavior, therefore these results do not directly support the hypothesis 4b. Nonetheless they are interesting from a theoretical point of view and will be discussed as a partial confirmation of the general expectations of this study.

6.4.2 The non-social avoidance model in participants with high BIS

This model was a 2 x 2 x 2 ANOVA with a between-subjects factor of group (similarity, dissimilarity) and within-subjects factors: valence (negative, neutral) and pre-post (pre-SIT, pre-SIT) on the number of avoidance responses and image size of non-social stimuli, in participants with high BIS. A trend of interaction was examined with post-hoc t-tests with Bonferroni corrected p values.





Participants with high BIS showed main effects of valence both on the number of avoidance responses (F(1) = 260.96, p < .0001, η_p^2 = .92) and on the image size (F(1) = 91.47, p < .0001, η_p^2 = .78). Negative non-social stimuli had more avoidance responses (M = 12.42, SD = 3.85) than neutral non-social stimuli (M = 2.39, SD = 2.02), as well as smaller image sizes (M = -8.63, SD = 5.23) than neutral non-social stimuli (M = 1.31, SD = 3.05). In addition to these main effects, a trend towards interaction between valence, pre-post and group was found on the number of avoidance responses (F(1) = 2.78, p = .097, η_p^2 = .11), as shown on Figure 7. Post-hoc analyses imply that the dissimilarity group showed an increase in the number of avoidance responses towards negative non-social stimuli (pre-SIT: M = 11.49, SD = 2.89; post-SIT: M = 13.08, SD = 3.8) (*T*(12) = -2.04, p = .256), while the similarity group did not show the change in avoidance responses towards negative non-social stimuli (pre-SIT: M = 12.55, SD = 4.42; post-SIT: M = 12.56, SD = 4.32) (*T*(12) = -.01, p = 1). There were no changes over time in avoidance of neutral non-social stimuli neither in the similarity (*T*(12) = -.82, p = 1) nor the dissimilarity group (*T*(12) = .83, p = 1).

It is important to note that, in the non-social avoidance model performed on the entire sample, an interaction between valence and pre-post showed that avoidance of negative stimuli increased over time regardless of group (F(1) = 11.21, p = .001, η_p^2 = .17), as reported in Chapter 6.3.4. Given this strong tendency shown on the entire sample, it is interesting that in the participants with high BIS this increase in avoidance appeared only in the dissimilarity group, while the similarity group there was no change. In the hypothesis 4b, it was expected that the similarity induction would *decrease* the avoidance of negative stimuli in participants with high BIS. Nevertheless, given that participants with high BIS of the similarity

group were the only ones *not showing the increase* in the avoidance of negative non-social stimuli, this trend could be considered consistent with the hypothesis.

6.5 Exploratory analyses

6.5.1 Additional effects of experimental manipulation

Pearson's correlation coefficients were calculated between the social closeness measure and the difference between post-SIT and pre-SIT for each stimulus category, in order to check whether the degree of social closeness was related to the effect of the experimental manipulations. There were no significant correlations between the social closeness measure and the pre-post differential value of any stimulus category. Spearman's correlation coefficients were calculated between the sameness measure and the pre-post difference for each stimulus category. There were no significant correlations with the number of approach/avoidance responses. The sameness measure negatively correlated with the pre-post change in the non-social neutral image size ($r_s = -.343$, p = .008), but there was no correlation with the other 5 stimulus categories. If we take into account that the social closeness measure reflected the difference between groups better than the sameness measure, as shown in reported t-test results, it can be concluded that, the level of self-reported social closeness is not related to the amount of change in any of the approach/avoidance measures between the pre-SIT task.

Regarding the answers to the Positive Affect Negative Affect Scales (PANAS), there was a decrease in positive affect after the SIT (M = 2.55, SD = .93), compared to before the SIT (M = 2.85, SD = .91) (F (1) = 32.069, p < .001, η_p^2 = .36), and it did not depend on experimental manipulation. There were no changes in the negative affect in any of the groups. This result shows that the change of the self-reports on affect did not depend on whether participants had similarity or dissimilarity condition.

6.5.2 Exploratory analyses of relations between trait measures and approach/avoidance measures

The number of the approach/avoidance responses and the image size of 6 stimulus categories were correlated with the total scores on the ASI, the BIS and the BAS, as well as to the scores on the sub-scales ASI-Cog and the BAS-RR. The correlations with ASI and ASI-Cog, as well as the correlations with BAS and BAS-RR, were corrected for multiple comparisons (Bonferroni). Pearson correlation coefficients were calculated. The main ASI score showed no significant correlations, but the ASI-Cog score positively correlated with the number of approach responses towards social neutral (r(56) = .309, p = .042) and non-social neutral stimuli (r(56) = .013, p = .026). The higher participants were on ASI-Cog, the more they approached neutral stimuli, both social and non-social. Furthermore, total BAS score positively correlated with the number of approach responses towards non-social positive stimuli (r(56) = .375, p = .008) and with the image size of the same stimulus category (r(59) = .384, p = .006). Just like BAS, BAS-RR correlated

with the approach responses (r(56) = .316, p = .034) and the image size (r(59) = .351, p = .012) of nonsocial positive stimuli., but in addition, it also correlated with the approach responses towards social positive stimuli (r(56) = .344, p = .018). These correlations show that participants higher on BAS and BAS-RR approached the non-social positive stimuli more, and that participants higher on BAS-RR also approached social positive stimuli more. The score on BIS showed a correlation with the number of approach responses towards social positive (r(56) = .32, p = .016) and social neutral stimuli (r(56) = .307, p = .021). Participants higher on BIS approached social stimuli more, both positive and neutral.

Furthermore, effects of median splits of ASI, ASI-Cog, BAS, BAS-RR and BIS on the number of approach/avoidance clicks and the image size were tested for each trait and sub-trait separately. Four 2x2 ANOVAs were used, which corresponded to the main four models used in the previous analyses: social approach, social avoidance, non-social approach and non-social avoidance. Between-subjects factor was a median split on each of the trait measures and within-subjects factor was valence (negative and neutral for the avoidance models; positive and neutral for the approach models). All statistics obtained in the analyses of ASI, ASI-Cog, BAS and BAS-RR were corrected for multiple testing, as in the previous analyses. Moreover, post hoc analyses of interactions were performed using independent-samples t-tests with Bonferroni corrections for p values.

Results showed that ASI did not affect the number of approach/avoidance responses nor the image sizes, as none of the models showed main effects of ASI nor the interactions between valence and ASI. The social approach model performed with ASI-Cog as a between-subjects factor and valence (positive, neutral) as a within-subjects factor showed a trend towards the main ASI-Cog effect on the approach responses towards social stimuli (F(1) = 4.057, p = .1, $\eta_p^2 = .078$). Participants high on ASI-Cog tended to approach positive and neutral social stimuli more (M = 5.95, SD = 3.27) than the participants low on ASI-Cog (M = 4.57, SD = 2.66). This trend is consistent with the reported correlation found between ASI-Cog and approach towards neutral social stimuli. Notably, no effects of ASI and ASI-Cog were shown on the avoidance behavior, even though it was expected that participants with higher anxiety sensitivity would avoid negative stimuli more than participants with lower anxiety sensitivity.

Regarding analyses performed with BAS, two models showed the effects of BAS on approach/avoidance behavior. The social approach model performed on the number of approach responses had BAS as a between-subjects factor and valence (positive, neutral) as a within-subjects factor. This model demonstrated a trend towards an interaction between BAS and valence (F(1) = 4.6, p = .074, $\eta_p^2 = .086$), shown on Figure 8a. Participants high on BAS had more approach responses towards positive social stimuli (M = 8.12, SD = 3.55) compared to the participants low on BAS (M = 6, SD = 3.24) (T(49) = -2.22, p = .062), while there was no difference in the number of approach responses towards neutral social stimuli (T(49) = -.78, p = .88) between participants high (M = 3.5, SD = 2.46) and low (M = 3.02, SD = 1.99) on



Figure 8. Interactions between BAS and valence: a) the social approach model on the number of approach responses, b) the non-social approach model on the image size

BAS. The non-social approach model performed on the image size had BAS as a between-subjects factor and valence (positive, neutral) as a within-subjects factor. This model showed significant interaction between BAS and valence (F(1) = 6.87, p = .024, $\eta_p^2 = .119$), as represented on Figure 8b. Participants high on BAS made positive non-social images larger (M =10.76, SD = 3.76) than participants low on BAS (M = 8.29, SD = 4.54) (T(49) = -2.13, p = .076), while the neutral non-social image sizes did not differ between participants high (M =.99, SD = 3.09) and low (M =1.38, SD = 2.25) on BAS (T(49) = .541, p = 1). The avoidance models showed no effects of BAS, as expected. These results indicate that participants higher on BAS approached positive stimuli more than participants lower on BAS, which is in line with the expectation that, since the individuals high on BAS are more sensitive to rewards, they would also show more approach behavior towards positive stimuli in the approach/avoidance task.

Analyses with BAS-RR show partially congruent results. A trend towards main BAS-RR effect was found in the social approach model on the number of clicks (F(1) = 4.831, p =.068, $\eta_p^2 =.103$), as participants high on BAS-RR had more approach responses towards positive and neutral social stimuli (M = 5.77, SD = 3.2) than participants low on BAS-RR (M = 4, SD = 2.72). The non-social model on the image size indicated a trend of interaction between BAS-RR and valence (F(1) = 5.321, p = .052, $\eta_p^2 =.107$). Participants with high BAS-RR made positive non-social stimuli larger (M = 10.55, SD = 3.97) than participants with low BAS-RR (M = 8.29, SD = 4.57) (T(40) = -1.71, p = .192), but they did not differ in the size of neutral non-social stimuli (T(40) = .513, p = 1).

Regarding the results obtained with the BIS median split, only the social approach model performed on the number of approach responses showed a significant effect of BIS (F(1) = 4.478, p =.04, η_p^2 =.085). Participants higher on BIS had more approach responses towards positive and neutral social stimuli (M = 5.71, SD = 3.32) than the participants lower on BIS (M = 4.25, SD = 2.6), which corresponds to the correlation found between BIS score and the number of approach responses to social positive and neutral stimuli.

7 Discussion

In this thesis, we were interested in whether the presence of socially close individuals increases approach and decreases avoidance towards social and non-social stimuli. It was expected that similarity induction would facilitate approach responses towards positive stimuli and that it would inhibit avoidance responses towards negative stimuli, with respect to dissimilarity induction. We expected these effects to be shown both for social and non-social stimuli. Furthermore, it was expected that hypothesized effects of social closeness on avoidance behavior would be stronger in participants with high anxiety sensitivity and high sensitivity of behavioral inhibition system (BIS), and that the effect on approach behavior would be stronger in participants with high sensitivity of behavioral activation system (BAS).

The results from the social closeness self-ratings showed that the induction of social closeness was effective, as participants of the similarity group showed higher social closeness ratings than participants of the dissimilarity group. Furthermore, two approach/avoidance (the number of approach responses and the image size) showed that participants gave more approach responses to positive than neutral stimuli and, accordingly, made positive stimuli larger than neutral stimuli. Also, participants gave more avoidance responses to negative than neutral stimuli and made negative stimuli smaller than neutral stimuli. This indicated that these two measures successfully differentiated between emotional (positive, negative) and neutral stimuli in expected directions, which was a precondition for testing the hypotheses. Third approach/avoidance measure - speed of approach/avoidance clicking - did not meet this precondition, thus it was excluded from further analyses.

The results show that the social closeness induction did not have significant effects on the approach/avoidance behavior in the main sample, as shown on both social and non-social, positive and negative stimuli, and both on the number of approach/avoidance responses and the image size. Based on these results, it can be concluded that our findings do not confirm the hypotheses that social closeness increases approach towards positive and decreases avoidance towards negative social and non-social stimuli. Furthermore, participants with high anxiety sensitivity did not show stronger effect of the social closeness on avoidance behavior, and neither did participants high in BAS show stronger social closeness effects on approach behavior. However, the analysis performed only on the participants with high BIS yielded several interesting findings. Namely, participants high in BIS of the similarity group did not show an increase of avoidance towards non-social negative stimuli after the SIT, while the dissimilarity group and the entire sample showed this increase. As discussed in Chapter 7.1.2, overall direction of this trend is

consistent with hypothesis 4b. Furthermore, the size of positive non-social stimuli increased after the similarity induction in participants high in BIS, while it did not change in participants high in BIS who went through dissimilarity induction. This effect is consistent with the expectation that social closeness would increase the approach behavior, although it was not expected to be stronger in participants with high BIS, but rather in participants with high BAS.

In this chapter, effects that were obtained from the data analysis will be discussed in the Chapter 7.1. Then, I will comment on some methodological limitations of this study, which could have affected the results (Chapter 7.2). Finally, the theoretical implications for our hypotheses will be discussed, as well as the implications for the future work that could be drawn from this thesis (Chapter 7.3).

7.1 Effects of social closeness on approach/avoidance behavior

7.1.1 Analyses on the entire sample

As reported in Chapter 6.2, a baseline difference between similarity and dissimilarity group was found, meaning that their responses differed before the experimental manipulation was performed. The similarity group showed higher number of approach and avoidance responses than the dissimilarity group for positive and negative stimulus categories. As both groups undergone the same treatment until the SIT part of the experiment, the found group differences should not be due to any systematic effect, therefore, they could rather be ascribed to a random error. The effects observed in the baseline make it more difficult to draw conclusions about the changes due to experimental manipulation, because these pre-existing group differences likely affected the interactions in all other models as well. We expect that the issue of baseline difference would have disappeared on a larger sample.

The approach models performed on the number of responses showed that positive stimuli were generally approached more than neutral, both in the case of social and non-social stimuli. This result was further confirmed by the approach models performed on the image size, as participants made the positive stimuli larger than the neutral, and the non-social positive stimuli larger than the non-social neutral. The avoidance models showed that both social and non-social negative stimuli had more avoidance responses than the neutral stimuli. The image size models consistently showed that the social negative stimuli were made smaller than the social neutral, and that the non-social negative stimuli were made smaller than the social neutral, and that the non-social negative stimuli were made smaller than the social neutral, and that the stimulus dimensions of valence and arousal were crucial for choosing whether to zoom-in or zoom-out and to what extent. As the positive/negative dimension is considered to be congruent to the approach/avoidance dimension in most cases (Elliot, 2008), this direction of responses was expected. It shows that positive stimuli in the Size Modification Task consistently induced approach behavior and negative stimuli consistently induced avoidance behavior, confirming that our task measured what it was intended to measure.

Models performed on the speed of approach/avoidance clicking showed faster approach towards positive than towards neutral stimuli, and faster avoidance towards negative than towards neutral stimuli. However, interactions of valence and sociality in baseline models showed that this expected pattern existed only for non-social stimuli, and not for the social stimuli. Thus the speed measure did not successfully differentiate between emotional (positive and negative) and neutral social stimuli. Note that this measure was included in the study because it was expected to decrease the differences in the approach/avoidance behavior towards social and non-social stimuli, which were shown on the number of clicks in the pilot study. However, this measure also showed a difference in the speed of approach between social and non-social stimuli. In sum, not only that the speed measure did not balance out the responses towards social and non-social stimuli, but it also poorly differentiated social stimuli of different valence. For these reasons, the measure of speed of approach/avoidance clicking was excluded from the analyses.

It is also worth mentioning that some models yielded significant or marginal pre-post effects that did not interact with the group, meaning that certain changes happened over time across both groups. As we did not have a third control group (i.e. a group that did not receive any experimental manipulation), we cannot claim what the causes of these changes might be. They could be due to some characteristics that both similarity and dissimilarity induction had in common, due to the passage of time, or some third factor. However, it is not known which of these factors were relevant for the observed pre-post effects.

7.1.2 Selective analyses in participants high in anxiety sensitivity, BAS and BIS

Before the discussion of these results, it needs to be again mentioned that these analyses were performed on the less than half of the main sample. Depending on the trait, total sample size was 25 or 26 participants. Therefore, these results will mostly be used to give us a clue of possible trends that might have existed in the data, which could be useful for the future work. However, these trends cannot confirm or reject the research hypotheses of this thesis, but rather give a useful input for the future research.

Based on the recent study, the participants higher on the ASI-Cog were expected to find negative stimuli especially relevant (Harari-Dahan & Bernstein, 2017). ASI-Cog is related to "the cognitive fear of dyscontrol due to anxious arousal" (Harari-Dahan & Bernstein, 2017, p. 108) and the authors expected that the relevance of negative arousing stimuli is higher for the persons more likely to experience such feelings. For this reason, in addition to the main anxiety sensitivity scale, we also performed analyses on its sub-scale ASI-Cog. As stated in Chapter 3, the social closeness induction was expected to have a larger effect on the approach/avoidance behavior towards the stimuli that participants find personally relevant. Therefore, it was expected that the social closeness would lead to a stronger decrease of avoidance in highly anxiety sensitive participants, as measured either by main ASI, or its sub-scale ASI-Cog. This expectation was not confirmed, as no effects of social closeness induction on approach/avoidance measures was found in participants high on ASI, nor in participants high in its cognitive aspect. This possibly implies that the

negative stimuli in our study were not especially relevant for anxiety sensitive participants as expected, or that similarity induction did not affect the behavior towards personally relevant stimuli (see discussion on methodological limitations in Chapter 7.3).

Behavioral activation system (BAS) represents sensitivity to positive, rewarding sensations (Gray, 1981). However, as stated by authors of the BAS/BIS inventory, BAS is not a coherent factor and its subscales are recommended to be used separately (Carver & White, 1994). The BAS aspects are: BAS-D (persistency in attaining goals), BAS-FS (tendency to actively seek new rewards) and BAS-RR (responsivity to rewards). From these three sub-scales, BAS-RR is most directly relevant for the responsivity to positive stimuli in our approach/avoidance task. Therefore, analyses were performed both with total BAS and BAS-RR. Similar to the above-mentioned assumption of Harari-Dahan and Bernstein for anxiety sensitivity (Harari-Dahan & Bernstein, 2017), we assumed that positive stimuli in our study would be more relevant for participants high in BAS and BAS-RR, thus that social closeness would show a stronger effect on an increase of approach towards positive stimuli for participants high in BAS and BAS-RR. This expectation was not confirmed by results of this study, meaning that positive stimuli might not have been especially relevant for participants high on BAS and BAS-RR, or that similarity induction did not affect behavior towards personally relevant stimuli (discussed in Chapter 7.3).

Finally, people with more sensitive behavioral inhibition system (BIS) are more sensitive to punishments and unpleasant sensation in general (Gray, 1981). Contrary to what was expected for BAS, we expected that for participants high on BIS negative stimuli would be especially relevant. Therefore, social closeness induction was expected to lead to a stronger decrease of avoidance of negative stimuli in participants high in BIS. A trend in line with this expectation was shown for non-social stimuli. The nonsocial avoidance model performed in participants with high BIS showed that the number of avoidance responses towards negative non-social stimuli increased in the dissimilarity group and did not change for the similarity group (Figure 7). This trend is not directly in line with the hypotheses, since it was expected that avoidance behavior would decrease in the similarity group, with respect to dissimilarity group. However, in the non-social avoidance model performed on the entire sample there was a main pre-post effect, showing that the number of avoidance responses generally increased over time (Chapter 6.3.4). Considering that, it is interesting that among the participants higher in BIS, only the dissimilarity group showed this general increase of non-social avoidance, while the similarity group did not. This might suggest that this difference between the similarity and the dissimilarity group is in the direction consistent with the hypothesis 4b. However, since these results are not significant and the models were also performed on small samples, it cannot be claimed with certainty that the hypothesis 4b is confirmed.

Moreover, participants with high BIS showed tendencies consistent to what would have rather been expected for the participants with high BAS, which are shown by the results from the non-social approach

model both on approach responses and on image size. The non-social approach model on image size showed that positive non-social stimuli got larger after the SIT in the similarity group, while the dissimilarity group showed no change, and this interaction was significant. Similarly, the non-social approach model on the number of approach responses showed that participants high in BIS of the similarity group showed increase in approach responses, while the dissimilarity group showed slight decrease, but both for positive and neutral non-social stimuli. These findings imply that participants from the similarity group higher on BIS showed a tendency to intensify approach behavior towards non-social stimuli after the similarity induction, shown both for positive and neutral stimuli on number of avoidance responses, and shown for positive stimuli on image size measure.

It can be concluded that participants with high BIS showed a dependence of approach/avoidance behavior on the type of experimental induction, which is in line with what was expected in the entire sample. It was not expected that a stronger effect of social closeness on approach behavior would be shown in participants high in BIS, as positive stimuli were not assumed to be especially relevant for this group of individuals. Possibly, participants with highly sensitive behavioral inhibition system were generally more sensitive to the social closeness induction, and not only to its effects on personally highly relevant (negative) stimuli. Note that these effects and trends were found only on non-social stimuli, while no effects nor trends were found on social stimuli. As baseline interactions between valence and sociality showed, differentiation between emotional (positive and negative) stimuli and neutral stimuli was more successful in case of nonsocial stimuli with respect to social, on both approach/avoidance measures used. Since difference between emotional (positive and negative) and neutral stimuli was smaller for the social stimuli, that might have made it harder to observe significant interactions with valence in social models.

7.2 Links between trait measures and approach-avoidance behavior

When it comes to the general trait-related tendencies in the approach/avoidance behavior, the participants with high anxiety sensitivity were expected to show higher avoidance of negative and arousing stimuli, since the experience of arousal might elicit additional negative affective consequences for them. This was not shown on our sample. Interestingly, the participants high in ASI-Cog showed a trend of higher number of approach responses to social neutral and positive stimuli than participants low in ASI-Cog. The ASI-Cog score also positively correlated with the number of approach responses towards social and non-social neutral stimuli. In sum, participants higher on ASI-Cog show higher tendency to approach positive and neutral social stimuli, but also neutral non-social stimuli. Participants with higher ASI-Cog were approaching the stimuli that do not elicit negative arousal more, but they did not avoid the negatively arousing stimuli more, as compared to participants lower on ASI-Cog.

The concepts of behavioral activation system (BAS) and behavioral inhibition system (BIS) are directly related to the concept of approach/avoidance behavior. If our task measured approach/avoidance behavior, it could be expected that individuals with the higher BAS scores, who are more sensitive to rewards, approach positive stimuli more than the people with the lower BAS scores, who are less sensitive to rewards. Correspondingly, individuals high on BIS could be expected to have more avoidance behavior towards negative stimuli than individuals low on BIS, as individuals with high BIS are more sensitive to non-rewards and punishments. The exploratory analysis of the effects of BIS and BAS scales on the approach/avoidance measures give rather ambivalent results.

The models in which median splits on total BAS and BAS-RR were used showed several effects in line with the expectations. Participants high on BAS showed a trend of more approach responses towards positive social stimuli than the participants low on BAS, and the effect with a same direction was shown for the positive non-social stimuli on the image size measure. Participants high on BAS-RR, made positive non-social stimuli larger and made more approach responses to the positive and the neutral social stimuli, compared to participants low on BAS. Furthermore, continuous BAS scores positively correlated to number of approach responses and image sizes of non-social positive stimuli. It can be concluded that the effects of the BAS scales are evidently in line with the expectations – an overall tendency of participants higher on the BAS scales towards higher approach to both social and non-social positive stimuli (sometimes also social neutral) reinforces the claim that zooming-in the positive stimuli in the Size Modification Task corresponds to the approach behavior.

Nonetheless, a similar conclusion cannot be drawn from BIS and the avoidance behavior. Participants with higher BIS did not show higher tendency to avoid any stimulus category. However, they approached social positive and neutral stimuli more than participants low on BIS. Correspondingly, continuous BIS score positively correlated with number of approach responses towards social neutral and social positive stimuli. These results show that there might be a tendency of participants higher on BIS to approach positive, especially social positive stimuli, more than people lower on the BIS. Given that the BIS should be directly related to the propensity to avoid punishing and unpleasant stimuli, the stimuli that we used did not elicit effects in line with this expectation. Since the negative stimuli were even more arousing than the positive stimuli (see Chapter 5.3.2), it is not clear why they failed to elicit higher avoidance tendency in people with higher BIS. These results are partially consistent with the previously reported facilitating effects of social closeness on approach behavior in participants high on BIS. It could be indeed the case that the positive stimuli were especially relevant for the participants above the BIS median, or that they were simply more responsive to the social closeness induction.

7.3 Methodological limitations

Since this study did not find the significant effects that would confirm the hypotheses, it is valuable to do an in-depth analysis of methodology and the theoretical background of the study, and hopefully produce ideas that could benefit future endeavors to address similar research questions.

7.3.1 Social closeness induction – was it close enough?

One of the methodological concerns is the questionable strength of social closeness induced by the Similarity Induction Task. The similarity group on average reported to have felt closer to the other participants in the room compared to the dissimilarity group, which was a significant difference. However, it is important to mention that the similarity group had the average score 1.063 on this scale, which is closer to the middle (0) than to the maximum of the scale (3), i.e. it is closer to reporting not to be sure whether one feels close to the others than to reporting to feel very close to them. Similarly, the dissimilarity group had the average score -.917, which is closer to the report of not being sure if one feels close (0) than to the report of not feeling close at all (-3). These results are complemented by the written answers of the participants on the feedback questions about the SIT. Around the half of the participants reported that the Similarity Induction Task felt more or less artificial. The most common answers, which appeared in both groups, were: that it felt somewhat or very artificial; that they do not feel like they really met the other people; that they could not really connect to others; that the fact that they did not know which person gave which answer made it harder to connect and get to know the others; that it would feel less artificial if they could see each other, or if they could talk to each other. Further, although the participants who reported to be convinced that the SIT was a computer simulation were excluded, 10 more participants doubted if the other answers were really coming from other participants. This feedback indicated that a substantial number of participants felt that the setting of the experiment made it harder for them to feel connected to the others in one way or another.

It is undisputable that the participants in the similarity group felt somewhat more connected after the SIT than they were before the SIT, but it was possibly not enough for the effects to last for 15 min after the task and to affect the behavior after the task. For this experimental design it is important to make sure that the presence of the other people in the room during the second run of the Size Modification Task really makes a difference. Visual contact and verbal interaction could possibly improve the effectiveness of the task. In the studies reviewed in the theoretical background that had a familiarity experimental condition, both if it was an induction (e.g. Declerck et al., 2010) or if it was the presence of a friend (e.g. Heinrichs et al., 2003), participants could see and/or communicate to a socially close person before or also during the subsequent task. Visual cues and being able to communicate could be important factors for both developing the interpersonal closeness, and for feeling the effects of a presence of the socially close person. Furthermore, a study by Seltzer et al. showed that speech with the buffering partner is necessary element for the social buffering to occur in children (Seltzer et al., 2012). This could also be an important element for the social closeness induction to affect the approach/avoidance behavior. Since the studies of social buffering in humans were mostly done with real-life friends or partners, ideally, we would want participants to feel at least for a short while as if they made new friends. A replacement of the SIT in this study could be one of *the self-disclosure tasks* (e.g. Sedikides, Campbell, Reader, & Elliot, 1999; Sprecher, Treger, & Wondra, 2013). The usual form of this task is that two participants, or a group of participants, ask eachother a list of the prescribed personal questions with a turn-taking reciprocity. In this process both listening and talking is equally important and it is most effective when the amount of disclosure is balanced between the participants (Sprecher, Treger, Wondra, Hilaire, & Wallpe, 2013). This method has been shown to elicit feelings of liking, closeness, perceived similarity, and enjoyment of interaction (Sprecher, Treger, & Wondra, 2013). Since the self-disclosure tasks include face-to-face verbal and visual interaction, we would expect that some of the factors that might have hindered the ability of the SIT to induce more intense and enduring feeling of social closeness would be eliminated in this task.

7.3.2 Commentary on the motivational relevance of the tasks

In the reviewed oxytocin literature, there was often a notion that a social context needs to be relevant and affective in order for oxytocin to increase salience of the relevant stimuli from that context (social salience hypothesis) (Shamay-Tsoory, et al., 2009), or that oxytocin increases approach and decreases avoidance only towards "personally relevant and emotionally evocative stimuli" (GAAO) (Harari-Dahan & Bernstein, 2014). If it was expected that in this study the relevant and affective social context could trigger oxytocin mechanisms, which would than subsequently affect responses to the *relevant* emotional stimuli, it is important to discuss how relevant the context of this experiment was. Results of the PANAS after the first and second run of the SMT showed that positive affect slightly decreased over time, equally in the similarity and the dissimilarity group, while negative affect did not change in any of the groups. If the affective context created by the SIT was relevant, we would rather expect an increase in positive affect in the similarity group, which would have lasted throughout the second run of the SMT. The absence of the positive affect increase could be understood in light of the discussion on the intensity of social closeness induction in the previous section. Furthermore, one can argue that, in addition to the selfreports, a more objective method of assessing the affect and arousal levels should be used. Following the physiologic indicators of arousal during the experiment, for example skin conductance (SC) and heart rate level (HR), could be used to assess how much the experimental context generally aroused the participants, which could be taken as an indicator how motivationally relevant it was.

The other side of this discussion is the relevance of the stimuli in the approach/avoidance task. The stimuli were picked based on their valence and arousal levels (see Chapter 5.3.2), which gives us a certain
confidence in claiming that they provided affective and arousing emotional content. However, this does not necessarily mean that all kinds of presented affective contents related to the approach/avoidance dimension in the same way. Although closely related, approach/avoidance is still a separate dimension from positive/negative affective valence, and their relation is likely much more complicated than 1:1 correspondence (Barrett & Wager, 2006; Kemp & Guastella, 2011). If we compare two typical negative stimuli, one social and the other non-social, this difference will become clear. In a typical social negative stimulus, one can see a person with a severed body part, e.g. a man without a leg sitting on the pavement. In a typical non-social negative stimulus, one can see a dirty toilet. Although these stimuli have similar valence ratings, the latter has on average more avoidance responses than the former. It is intuitively more straight-forward that the image of a toilet should be avoided than a person with a severed body part. A similar comparison can be made between positive images. The view of an ice-cream and of a smiling person likely have quite different levels of complexity and meaning to participants. Even though they both make us feel good, approaching the ice-cream physically very closely feels more common and straight-forward than approaching another's face very closely (unless it is a partner or a friend). This observation is corroborated by the finding that the non-social emotional images in general had more approach and avoidance responses and also higher speed of clicking than the social stimuli. Therefore, while designing an approach/avoidance task, it is probably important to regard affective valence and approach/avoidance tendency as separate dimensions, and possibly to take into account more abstract vs. more direct meanings that approach/avoidance can have for humans. An alternative idea for the task would be to use emotional conditioning of otherwise neutral social and non-social stimuli. This way, approach and avoidance tendencies would be induced indirectly, and the conditioned stimuli would be social and non-social but highly comparable in other respects.

As stated in Chapter 7.1.1, the main conclusion about the Size Modification Task based on the results is that the positive emotional stimuli consistently elicit more approach responses than the neutral stimuli, and that the negative emotional stimuli consistently elicit more avoidance responses than the neutral stimuli. However, around 16% of the trials also contained incongruent responses (i.e. approach to negative images and avoidance of positive images). The trait dimension of the behavioral activation system (BAS) was related to tendency to approach positive stimuli. Answers on the behavioral inhibition system (BIS) were not related to the avoidance of negative stimuli. Altogether, these results suggest that the Size Modification Task mostly elicited balanced responses in the expected direction. However, the relation between the SMT responses and the three trait measures should probably be assessed in a bigger sample, as 59 participants possibly did not provide large diversity in the levels of the measured traits.

7.4 Theoretical considerations

The hypotheses of this study were based on the idea that the presence of socially close people activates the same oxytocinergic mechanisms that have been shown to increase approach behavior and decrease avoidance behavior in previous studies (Cohen, et al., 2017; Harari-Dahan & Bernstein, 2017). Even if the hypotheses were confirmed, we could not claim with any certainty that the induction of social closeness activated the oxytocinergic mechanisms. Nonetheless, confirmation of the hypotheses would be a good basis for hypothesizing that social closeness affects approach/avoidance behavior through OT mechanisms, since the design of this behavioral study has a lot in common with the design of a previous psychopharmacological with oxytocin (Harari-Dahan & Bernstein, 2017). Therefore, the confirmation of our hypothesis would have been consistent with the idea that the presence of a socially close persons not only decreases stress-response, but affects general approach/avoidance behavioral tendencies, possibly mediated by oxytocin. However, since our hypotheses were not confirmed, it is worth to critically examine the extent to which the theories and studies stated in the theoretical background support the hypotheses of this study, with a special focus on the effects confirmed in humans.

There are two important premises of this study. The first is that the presence of socially close persons leads to an increase in the oxytocin circulation in the areas such as the PVN of the hypothalamus and the amygdala, which mediates the social buffering effect. The second is that oxytocin increases approach towards positive and decreases avoidance of negative stimuli via the brain areas responsible for the regulation of approach/avoidance behavior. Both of these premises are empirically supported, however, this was usually done in animals (e.g. Smith & Wang, 2014; Lukas, et al., 2011), and more studies are needed to unequivocally confirm these findings on human population. This is especially important because both social buffering and approach/avoidance behavior are probably much more complex in humans than in animals, since they are affected by factors such as language, higher cognition and culture (Kiyokawa & Hennessy, 2017; Eder et al., 2013). I will try to critically examine what could be concluded from existing human studies on both of these premises, and is of direct relevance for this study.

Regarding the first premise, there are several human studies that support the claim that oxytocin mediated the stress-reducing effects of social buffering (Chen, et al., 2011; Seltzer et al., 2012); Heinrichs et al., 2003). Importantly, a neurogenetics study directly showed that oxytocin mechanisms are of crucial importance for social buffering to occur in humans (Chen, et al., 2011). Furthermore, it was shown that the social buffering effect was accompanied by a higher release of oxytocin (Seltzer et al., 2012), and that the administration of OT exacerbates the effects of social support in a stressful situation (Heinrichs et al., 2003). These findings clearly suggest that oxytocin is important for social buffering in humans, but it is still not known much about the specific oxytocinergic mechanisms that are employed. Kikusui et al. stated in their

model of the role of oxytocin in social buffering that the heightened level of oxytocin in the presence of a familiar person affects processes in the hypothalamus, the amygdala and the nucleus accumbens (Kikusui, Winslow, & Mori, 2006). Note that the NAc and the amygdala were also hypothesized to mediate the effects of oxytocin on approach/avoidance behavior (Harari-Dahan & Bernstein, 2014). Since the studies that support these claims are mostly done on animals, it would also be relevant to know whether the presence of socially close persons increases the concentration of oxytocin in these key areas in humans as well.

Moreover, there is a second important issue regarding the first premise. One of the defining characteristics of the social buffering effect is that it occurs when a person is accompanied by a familiar individual in *a stressful situation*. The relevant aspect of the social buffering effect for our topic is the power of socially close people to reduce levels of anxiety and withdrawal behavior. What distinguishes our set-up from the social buffering is that social buffering involves being in a stressful situation, while we did not necessarily induce a state of stress during the approach/avoidance task. Negative emotions were elicited by the negative stimuli, but they hardly induced a state of stress, as also implied by low self-ratings of negative affect (measured by PANAS). To what extent can the findings from the social buffering studies be extended to such rather calm situations? It would probably be useful to perform a study of the effects of social closeness on approach avoidance behavior, in which the levels of stress would also be varied, as it is possible that the presence of others has stronger effects in stressful situations. Ideally, this study would also involve assessing oxytocin levels, or administering oxytocin.

The second premise is that oxytocin increases approach and decreases avoidance behavior via its activity in the brain areas responsible for the general approach/avoidance processing. The idea that oxytocin affects the general tendency to approach and avoid relevant stimuli in the environment is relatively new, at least when it comes to research on humans. While some studies showed that oxytocin increases social approach (Cohen, et al., 2017; Radke et al., 2013) and decreases social avoidance (Roelofs, et al., 2010) the effects on non-social approach/avoidance behavior are usually not researched. Harari-Dahan and Bernstein showed that oxytocin decreases avoidance of negative social and non-social stimuli in individuals with high levels of anxiety sensitivity (Harari-Dahan & Bernstein, 2017). More studies are certainly needed in order to better understand oxytocin effects on approach/avoidance behavior, as well as to better understand the specific mechanisms that underlie it. Studies in humans that relate oxytocin administration with activity of the amygdala (Kirsch, et al., 2005; Gamer et al., 2010) and up-regulation of dopaminergic systems (Love, 2014; Skuse & Gallagher, 2009) give promising results, although there are also some contradictory findings (Striepens, et al., 2014). When it comes to the dispute of social-specific vs. general role of oxytocin, it is still not resolved whether social and non-social salient stimuli are processed by the same brain mechanisms (Ruff & Fehr, 2014), or whether they are processed in a fundamentally different way (Adolphs, 2010; Dunbar, 1998). Therefore, more studies that would systematically compare the effects of oxytocin on

approach/avoidance behavior to social and non-social stimuli are needed to give insight into the plausibility of the general approach/avoidance hypothesis of oxytocin.

The research questions of this thesis made a leap forward in hypothesizing the effects of social closeness on general approach/avoidance behavior. Nonetheless, both premises of this thesis are based on research topics that still have many unresolved issues and are still in early development. Importantly, the topics that should continue being addressed in human participants are the effects of OT on approach/avoidance behavior, and the mediatory role of oxytocin in social buffering, since, at the moment, the majority of the studies on these topics are performed on animals. Apart from developing the already existing lines of research, it is also important to directly connect them. Studies that would take oxytocin administration, social closeness induction, approach/avoidance behavior, and possibly also stress induction into account would be highly valuable, not only for understanding the effects of the social closeness on approach/avoidance behavior should be also examined independent from the potential OT mediation. It is likely that other brain mechanisms could also be relevant, especially dopamine and the opioid-mediated ones, with both systems having an important role in approach/avoidance behavior (Harmon-Jones, 2011) and in establishing social closeness (Panksepp, et al., 1978; Loseth, Ellingsen, & Leknes, 2014).

8 Conclusion

The aim of this thesis was to test the effects of social closeness induction on approach/avoidance behavior towards social and non-social stimuli. First, it was expected that the social closeness induction would increase approach behavior towards social positive stimuli and decrease the avoidance behavior towards social negative stimuli. Second, the social closeness induction was expected to affect approach/avoidance behavior towards non-social stimuli in the same manner. Finally, it was expected that individual differences in anxiety sensitivity, the BIS and the BAS could modulate the effects of social closeness on approach/avoidance behavior. For the participants with the higher anxiety sensitivity scores and with the higher BIS scores, the social closeness induction was expected to lead to a stronger decrease of avoidance behavior towards both social and non-social stimuli, compared to the general sample. For the participants with higher BAS scores, the social closeness induction was expected to elicit a larger increase in approach behavior towards social and non-social stimuli.

The results from the entire sample showed that our social closeness induction did not cause an increase in any of the approach behavior measures, nor a decrease in any of the avoidance behavior measures. Therefore, the results did not confirm the main hypotheses of this study. There were also no

significant effects in line with the predictions about the ASI, the BAS and the BIS scores. However, several trends were observed, some of which are consistent with the hypotheses, and others rather unexpected. First, there was a general tendency of an increase in avoidance behavior towards the non-social negative stimuli over time. However, participants higher on the BIS score who went through the social closeness induction did not show this increase of avoidance towards non-social negative stimuli. This trend has a direction in line with the expectations. Also, approach behavior towards positive non-social stimuli was significantly increased after the social closeness induction in participants higher on BIS. As participants higher on BIS were expected to show stronger effects in avoidance and not approach behavior, these results were somewhat unexpected, but nonetheless interesting. These trends indicate that it is plausible to test the hypotheses again with improvements based on what was learned from this study, since these trends could possibly point to true effects.

It can be concluded that, even though the findings of this study did not confirm its hypotheses, the study yielded some interesting results that could be relevant for the future work on this topic. Efforts should be made to improve methods to experimentally induce social closeness, to reassess the approach/avoidance task built for this study, and to possibly monitor affective changes throughout the experiment more accurately. Finally, it would be highly beneficial to conduct a similar study including an oxytocin manipulation, which would help us understand whether oxytocin mechanisms could be involved in the effects of social closeness induction on the approach-avoidance behavior.

9 References

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11 Appendices

11.1 Appendix 1 – The Pilot study: Size and Time Modification

Two approach-avoidance tasks have been developed for this study: Time Modification Task (TMT) and Size Modification Task (SMT). The tasks have been tested on a pilot sample of 55 female students of the University of Vienna, Faculty of Psychology (28 completed the TMT and 27 the SMT), aged between 18 and 42 (M = 21.53, SD = 4.02). The aim of this pilot study was to test for each task: (1) whether the task elicits the similar number of approach and avoidance responses, (2) whether the positive stimuli consistently elicit approach responses and negative stimuli avoidance responses, (3) whether emotional (positive and negative) stimuli elicit more responses than neutral stimuli. The SMT was chosen for the main study, as it met these criteria more successfully.

The Time Modification Task

In this task, participants were presented with the same emotional images used in the main study, presented one after the other. If not interfered with, each stimulus appeared on the screen for 8 seconds. In each trial participants could modify the presentation time by clicking the button UP on the keyboard to increase the time (approach response), and/or by clicking the button DOWN on the keyboard to decrease the time (avoidance response). There were no limits to how many times one could to click UP and/or DOWN. The maximum length of the stimulus presentation was 12 s, and the minimum 5 s. However, the time change that could be accomplished by clicking was fixed so that the participant could reach around 70% of both 8-12s and 8-5s time distance, by using different logarithmic formulas for two directions. This was done in order to balance out the maximal effects one can make when clicking UP and clicking DOWN, and by doing so to make the approach and the avoidance condition more comparable. In each trial there was a small graphic scale bellow the picture, showing how much time passed and how much is remaining, as and it changed together with the participants' clicks. There was an explicit instruction to focus gaze on the image, as the scale was recognized as a potential visual distractor. Although the time of each trial could vary from participant to participant, the total length of the experiment was controlled, through one break in the middle and one break around the end of the task. This task was modeled after the task made by Aharon et al. and used by Harari-Dahan and Bernstein (Aharon, et al., 2001; Harari-Dahan & Bernstein, 2017).

The number of approach/avoidance responses and trial time per valence stimulus category for the TMT can be seen on the Table 2. The average number of approach and avoidance responses significantly differed (T(27) = 4.15, p < .0001), as the number of avoidance responses is more than two times higher than the average number of avoidance responses. Regarding the positive stimuli, the number of avoidance responses was still higher than expected, since positive images were not expected to elicit any avoidance

reactions. The number of avoidance responses was also higher than the number of approach responses for the neutral stimuli (T(27) = 5.07, p < .0001). The overall number of responses elicited by positive and neutral stimuli did not differ (T(27) = 0.66, p = .51). The marginal difference between the number of responses elicited by negative and positive stimuli was found (T(27) = 1.993, p = 0.056), as negative stimuli elicited more responses than positive. An interesting finding was also that the overall number of responses to non-social stimuli was higher than the number of responses to social stimuli (T(27) = 6.205, p < .0001), and this was also the case for approach (T(27) = 2.889, p = .008) and avoidance (T(27) = 4.479, p < .0001) responses separately.

M(SD)	the time modification task $(N = 28)$			the size modification task $(N = 27)$		
	Approach resp.	Avoidance resp.	Trial time (ms)	Approach resp.	Avoidance resp.	Image Scale
total	3.07 (3.34)	6.45 (3.89)	7468.92 (560.09)	3.37 (1.78)	3.4 (1.27)	0.523 (0.05)
positive	6.58 (6.87)	2.38 (2,72)	8204.63 (547.6)	7.04 (3.52)	0.34 (0.64)	0.616 (0.06)
neutral	1.75 (2.75)	6.55 (4.95)	7340 (537.84)	2.63 (2.17)	0.93 (0.8)	0.534 (0.04)
negative	0.875 (1.21)	10.43 (5.6)	6862.12 (594.83)	0.43 (0.68)	8.94 (3.51)	0.42 (0.04)

Table 2. Pilot study: the average number of approach/avoidance responses on the Time Modification Task

and the Size Modification task

The Size Modification Task

For the description of the task, see Chapter 5.3.2. The descriptive statistics of the SMT can be seen on the Table 2. The overall number of approach and avoidance responses does not differ in this task. There were almost no avoidance responses for positive stimuli, nor approach responses for negative stimuli, which met previously set criteria perfectly. In contrast to the time modification task, there was more approach than avoidance responses for the neutral stimuli (T(26) = 3.79, p < .0001). Furthermore, there was a higher number of responses to the negative than to the positive stimuli (T(26) = 3.15, p < .0001), just like in the TMT. However, there were less responses to the neutral than to the positive (T(26) = 8.41, p < .0001) and negative (T(26) = 8.62, p < .0001) stimuli, which is more in line with the criteria. Finally, a difference in the number of responses to social and non-social stimuli was also found in the SMT. The non-social stimuli elicited more responses than the social stimuli (T(26) = 8.42, p < .0001), and that was the case both for approach (T(26) = 4.72, p < .0001) and avoidance (T(26) = 5.38, p < .0001) responses.

Based on these results, we have decided to use The Size Modification Task in the final study, since it was more successful at meeting the previously set criteria. While in the TMT participants generally showed tendency to press 'down' more than 'up', in the SMT the average number of approach and avoidance responses did not differ. Furthermore, while in the TMT there was a high number of incongruent responses (avoidance for positive stimuli), in the SMT there is almost no avoidance responses for positive not approach responses for negative stimuli. The TMT also showed a higher number of avoidance responses for the neutral stimuli. Although the SMT showed an opposite bias for the neutral stimuli, as approach responses appeared more often than the avoidance responses, this difference is much smaller than in the TMT. Furthermore, the TMT did not differentiate well between neutral and positive stimuli, as the number of responses did not differ between these two categories. This is strongly opposed to the criteria that neutral stimuli should elicit less approach and avoidance compared to the emotional and relevant stimuli (positive and negative). This issue did not appear in the SMT data. Finally, both tasks showed higher number of approach and avoidance responses to non-social stimuli than to social stimuli, which was not expected. In the main study, we decided to include the measure of the speed of approach/avoidance clicking (the number of clicks per second from the moment of first to the moment of last click in trial), in addition to the number of responses, which could possibly compensate for this difference. If there was a longer latency for responding to the social stimuli, that could be a possible reason for the smaller number of responses in the fixed time frame of 4s. If this assumption was correct, the speed of clicking would be a better indicator of the intensity of response for the social stimuli than the total number of clicks.