universität wien

Diplomarbeit

Titel der Diplomarbeit

I Like You When You Think Like Me: The Effects of Congruent and Incongruent Mental States on Empathy and Prosocial Behavior

Verfasserin

Sandra Amashaufer

Angestrebter akademischer Grad

Magistra der Naturwissenschaften (Mag. rer. nat.)

Wien, 2014

Studienkennzahl:	298
Studienrichtung:	Psychologie
Betreuerin:	Dr. Jasminka Majdandžić

Acknowledgements

At this point, I would like to express my gratitude to all the people, who tremendously contributed to my work in many different ways and assisted me during composing and writing my diploma thesis.

First and foremost, I want to thank my supervisor Dr. Jasminka Majdanžić for her outstanding help and support. Not only she was always reachable and helpful with words and deeds, but also very patient and motivating at all times, no matter what difficulties we had to overcome. Working with her on the current thesis was a great pleasure for me.

Furthermore, I very much appreciated the help of my fellow students Isabell Niedermoser, Nyala Noë and Pilvi Rainesto, who assisted me during data acquisition. A big *thank you* to all three of them for spending so much time with me at the MR-centre, even sacrificing their time on weekends and neglecting their own workload to make data acquisition possible, fast and trouble-free for me.

Besides, I would like to thank every single participant, who took part in my study. All of them have been really kind, patient and cooperative while voluntarily participating in the experiment.

Last but not least, my thanks and appreciation go to my family, who supported me whenever necessary and therefore enabled me to pursue my studies. Trying to help in every way they could, they were always there for me, motivating and encouraging me in every step of my diploma thesis, from developing and carrying out the experiment until finishing my thesis.

Table of contents

Abstract

According to the simulation theory, people use themselves as a template when inferring other persons' mental states. Thus, it should be easier to mentalize with people who are similar to ourselves. The current study sought to clarify the mechanism behind the link, which has been found between mentalizing and prosocial behavior: is it the perceived similarity between the participant and the target person, which leads to higher empathy ratings and greater prosocial behavior, or can this link be explained by means of an increased familiarity of the target persons elicited due to the priming. Using fMRI, the influence of congruent and incongruent mental states of two fictitious target persons on the participants' empathic concern and prosocial behavior towards them was examined. The congruency induction by means of similar and dissimilar mental states was implemented in an implicit priming task prior to the actual empathy and prosocial tasks. Our analyses revealed increased activation in the ventrolateral prefrontal cortex (VLPFC) during mentalizing with incongruent persons, suggesting that a higher extent of uncertainty dominates in these trials and hence, the participants have to inhibit their first impulse in order to pick the opposite statement for the incongruent person. Furthermore, it could have been shown, that congruent mental states of target persons do have an effect on the amount of empathy felt towards them, driven by non-painful trials. The imaging data did not reveal any activation differences in brain areas, which are classic for empathy, but it yielded increased activation in the left temporoparietal junction (TPJ) when empathizing with the congruent target person. This shows that there seems to be a need for the participants to actively disengage themselves from the congruent person, in order to not being overwhelmed by the extent of empathy, which they feel due to a greater merging with the similar person. Additionally, the imaging results of the mentalizing task could account for the assumption that it is more difficult for people to mentalize with dissimilar persons in comparison to mentalizing with similar persons. However, we did not find any effects of similarity on decisions made in the prosocial task.

Theoretical Background

The ability to think about and predict the mental states of other people is described as *mentalizing*, where mental states are referred to as beliefs, thoughts, feelings, desires and intentions (Frith et al., 1991; Majdandžić et al., 2012; Mitchell et al., 2006). Mentalizing corresponds to "theory of mind" (Frith & Frith, 2003) and characterizes the process of thinking about and reading the intentions, desires or beliefs of other people as well as representing the mental states of others (Amodio & Frith, 2006; Frith & Frith, 2003). There are two viewpoints of how mentalizing or theory of mind, respectively, works out: the theory-theory and the simulation-theory (Carruthers and Smith, 1996). The theory-theory on the one hand states, that we are endowed with a certain theory about mental states and their relationships to each other and by means of this concept we are able infer the minds of others (Saxe, 2006). The simulation-theory on the other hand suggests, that people use themselves as a template when inferring other persons' mental states (Goldman, 2006). The literature states, that the mental states of our fellow men are comparable to those we experience ourselves and therefore we are able to infer their thoughts and subsequently their behavior (Tomasello, 1999; Mitchell et al., 2006). Mitchell and colleagues (2006) argue, that this process only applies for individuals who are not substantially different from ourselves because the knowledge we have due to our own experiences is not very useful when inferring the mental states of someone from another culture or ethnic group. According to this self-referential concept of the simulation-theory, we are able to project ourselves in the position of other people, imagining what we would feel or think in a certain situation and subsequently attributing the output of this imagination to the target person (Mitchell, 2008). So we use our own first-hand experience as guidance to adopt the perspective of others and therefore predict their mental states (Gallese & Goldman, 1998; Mitchell, 2005). Our knowledge of the world and the application of past experiences to current situations as well as observations and predictions of others' behavior help us to understand the mental states of other people (Frith & Frith, 2003). In addition, mentalizing is a unique cognitive ability that distinguishes humans from other animals (Contreras et al., 2013).

Numerous fMRI-studies revealed a network of brain areas, which are active during mentalizing tasks. This so-called "mentalizing system" includes the medial prefrontal cortex (mPFC), the precuneus/posterior cingulate cortex (pCC), the right posterior superior temporal sulcus (STS)/temporoparietal junction (TPJ), the temporal poles bilaterally and the amygdala

(Frith & Frith, 2003; Mitchell, 2008). Most of the studies that used or examined mentalizing found activation in the mPFC, which leads to the conclusion that the mPFC plays a crucial role in mentalizing (Mitchell, 2008; Gallagher & Frith, 2003). Some of these studies could show, that the ventral part of the mPFC is involved in judgments about oneself and about others who seem to be similar to oneself, regarding their mental states, whereas the more dorsal part of this region is activated when judging dissimilar others (Mitchell et al., 2006; Dumontheil et al., 2010). The STS/TPJ region yields activation when perceiving biological motion and intentional behavior as well as when observing and retrieving information about people's behavior (Frith & Frith, 2003; Gallagher & Frith, 2003). The TPJ and the precuneus are involved in both emotion and intention mentalizing, with the precuneus being more activated in emotion mentalizing, and both areas are stronger activated while inferring other persons' mental states instead of physical reasoning (Atique et al., 2011). Additionally, the TPJ is known to play a role in self-other distinction (Lamm & Decety, 2007). Activation in the temporal poles, especially on the left side, is elicited when retrieving scripts or memories about personal experiences (Frith & Frith, 2003; Gallagher & Frith, 2003). Additionally, there is activation in this area when creating a semantic and emotional context for our processed impressions, based on former experiences (Frith & Frith, 2003).

Previous studies found a connection between this human ability to mentalize and prosociality (e.g. Majdandžić et al., 2012; Waytz et al., 2012). Prosocial behavior describes voluntary actions that are carried out to foster other people as well as preserve their well-being and it includes behavior patterns like helping, sharing, comforting, donating, cooperating and volunteering (Eisenberg et al., 2006; Brief & Motowidlo, 1986; Batson & Powell, 2003). The consideration of the mental states of others is directly related to altruism: Waytz and colleagues (2012) claim, that it is rather the understanding of other people's thoughts, feelings or desires that leads to increased prosocial behavior instead of empathy per se. Higher activation in the mPFC, an area that is involved in mentalizing, predicts prosocial behavior in form of higher money donations and a greater amount of time used to help others (Frith & Frith, 1999; Waytz et al., 2012). This finding suggests, that prosociality stems from understanding the mental states of others (Waytz et al., 2012). Majdandžić and colleagues (2012) could show, that thinking about the mental states of fictitious persons leads to less utilitarian decisions in moral dilemma situations. This means, that fictitious persons, whose mental states have been described extensively, are sacrificed less often than people whose mental states have not been reflected (Majdandžić et al., 2012). Waytz and Young (2012) found in their study about attributing a mind to groups and their members, that the

consideration of other people's mental states has an effect on altruistic behavior. They could show, that the extent of activation in the mPFC is correlated with the willingness to help others.

Another topic, which we want to address in the current study, is pain-related empathy. Empathy describes the ability to feel with another person and share the other's affective states, both consciously or unconsciously. The experience of empathy allows us to comprehend, what is going on in other people when they are feeling emotions or sensations like happiness, sadness or pain (Gallese, 2003; Singer et al., 2004). Feelings of empathy are not only exhibited towards known or familiar people, they even can be extended to strangers or members of different groups (Decety, 2011). According to Lamm and colleagues (2007), there are three major components in the concept of empathy: the affective response towards another person, perspective-taking in order to understand the behavior of the other person and monitoring mechanisms to retain the source of the feeling. As empathy is thought to stem from the comprehension of the emotional states of others, mental states of the observer, which are evoked while the person perceives pain in others, are an important factor for empathic processing (deWaal, 2008; Jackson et al., 2005). Lamm and colleagues (2007) state, that cognitive processes can influence the reactions of people towards the pain of their fellow men: taking into account the other's perspective causes stronger empathic concern. Imagining how another person feels in a certain situation evokes feelings of empathic concern and subsequently leads to altruistic motivation to ease the other's distress (Lamm et al. 2007; Batson et al., 1987).

Study results suggest, that common neural structures are active both while receiving pain oneself as well as when watching others experiencing painful sensations (e.g. Gallese, 2003; Lamm et al., 2007). The pain-related network, which comprises brain areas that are stronger activated by painful stimuli, is referred to as the "pain matrix" and includes insular regions, the anterior cingulate cortex (ACC), primary (SI) and secondary (SII) somatosensory cortices, thalamus, prefrontal and posterior parietal cortices, striatum, cerebellum, periaqueductal grey and the supplementary motor area (Peyron et al., 2000). Singer and colleagues (2004) state, that empathizing with others does not require the whole matrix to be activated, but rather those parts which are associated with the affective dimension of pain. When focusing on the affective parts of pain, we expect to see stronger activation in the anterior insula and the anterior midcingulate cortex – areas, which are involved in processing the affective dimension of pain (Jackson et al., 2005; Lamm et al., 2007).

Based on the simulation theory, mentalizing should increase the self-other overlap between one's own mental representations and the internal states of others because we mentally transfer ourselves in a similar situation as the other is exposed to and use our own knowledge and experience when inferring the minds of others (Preston & Hofelich, 2011). As a result, mentalizing might also facilitate the ability to empathize with other persons because shared representations are thought to be the basis for empathy (de Vignemont & Singer, 2006). According to Völlm and colleagues (2006), empathy and theory of mind both activate similar brain regions, which are engaged in social perception and build the basis for making inferences about mental states. These regions include the mPFC, temporal poles and the superior temporal lobe (Völlm et al., 2006). In addition, the literature suggests that mentalizing and prosocial motivation, among other processes, constitute empathy and that theory of mind is crucial for empathic reactions (Zaki & Ochsner, 2012; Ciaramelli et al., 2013). In this context, the perception of others is an important factor. Depending on how the target person is perceived, including how similar (i.e. Ames, 2004) and how likeable (i.e. Singer et al., 2006) he or she seems to be, the mechanisms of empathy can be cognitively modulated (Decety et al., 2009). In general, the more experiences people have in common with the target person, the better they should be at empathizing with them (Hodges & Wegner, 1997). Since the simulation theory states, that the self is used as a template during mentalizing, there should be stronger effects of mentalizing on empathy and subsequently also on prosocial behavior, if this results from empathy, for similar persons in comparison to dissimilar persons. Therefore, testing the effects of similarity felt towards the persons mentalized with should shed light on the question, if such a process of self-projection indeed takes place during mentalizing.

As mentioned above, there is also a link between empathy and prosocial behavior because empathic arousal is an important factor for developing prosocial motivation (Decety, 2011). The literature states, that there are various dispositional and situational predictors and factors, which are able to evoke prosocial behavior. These factors include for example egoistic concerns, other-oriented concerns, ambiguity and severity of need, cost of helping, moral values or even personal factors like intelligence and self-esteem (Eisenberg, 2007; Batson & Powell, 2003). Empathy is one of the mechanisms that may underlie altruistic behavior in response to other persons' pain or need and leads to helping behavior when observing people in distress (Goldman, 1992; deWaal, 2008; Batson et al., 1981). Hein and colleagues (2011) showed, that the similar the level of skin conductance is in response to receiving painful stimuli oneself and watching others receive the same stimuli, the higher is

the possibility to exhibit prosocial behavior. On the other hand, Hein and Singer (2008) claim, that it is not empathy per se, that elicits prosocial behavior, but rather a transformation or specific form of it, which is called sympathy (Eisenberg, 2007) or empathic concern (Batson et al., 1987).

The study at hand should now extend the findings of previous studies in regard of congruency and incongruity of mental states and their influence on pain-related empathy and prosocial behavior. According to the simulation account, it should be easier for people to mentalize with similar others. So if this simulation theory applies for mentalizing, similar mental states of the target person should lead to greater effects on empathy and prosocial behavior. The question arises, if it is the perceived congruency between the participant and the target person, caused by considering the mental states of this person, which leads to greater prosocial behavior and higher levels of empathy? Or are there other explanations, like for example increased familiarity or a general priming effect due to thinking about the other's mental states, which could account for the effects that have been found in previous studies? To test our hypotheses we are using mentalizing tasks to prime the participants prior to examining their pain-related empathy and prosocial tendencies.

Furthermore, the current study should start at the limitations of the aforementioned studies. Since Majdandžić et al. (2012) used exclusively fictitious target persons in their study, it is not clear if the effect that was found would also occur among „real" people. In addition, the decision-making behavior when sacrificing fictitious persons might differ from the behavior of the participants in real situations. The study done by Waytz and colleagues (2012) is limited because they only calculated a correlation between the measurement and the behavior. There was no experimental manipulation that could have shown a direct connection.

The current scientific study is conducted to shed light on the link between mentalizing and prosocial behavior as well as on the effects, which mentalizing has on empathy. As previous studies found a link between mentalizing and prosocial behavior (e.g. Majdandžić et al., 2012; Waytz et al., 2012), we want to extend these findings in the current study in regard to the congruency of mental states. The question here is, if this link between mentalizing and prosocial behavior just occurs or probably occurs stronger in congruent conditions, in which the target person mentalized with shows the same preferences, thoughts, desires or intentions as the participant does. We hypothesize that the effects which mentalizing has on prosocial behavior are stronger, if the person mentalized with has congruent mental states in comparison to the participant. In line with our hypothesis, the participant should act more prosocial towards the similar co-player, who seems to have more matches in terms of mental

states. Vice versa the participant should not act more prosocial towards the dissimilar co-player, because this player has not much in common with the participant when it comes to attitudes, desires or intentions.

As stated above, cognitive processes and adopting the perspective of others can modulate empathic concern. By means of a mentalizing task we want to create feelings of similarity and dissimilarity, respectively, between the participant and the two fictitious co-players. Hence, we want to examine if there is a difference in the extent of empathy, which participants exhibit towards a target person with congruent mental states on the one hand and a target person with incongruent mental states on the other hand. We assume that participants indicate higher ratings of empathy and increased brain activation in areas involved in the pain matrix when empathizing with the congruent target person and lower empathy ratings as well as decreased brain activation in the pain matrix when empathizing with the incongruent target person.

Moreover, the literature suggests that empathy, and more precisely empathic arousal, is the key element that is needed for people to exhibit prosocial behavior (Goldman, 1992; deWaal, 2008; Decety, 2011). Therefore, we hypothesize that the effects, which mentalizing has on prosocial behavior, are mediated through the level of empathy felt towards the two fictitious target persons. Hence, if people emphasize more with a particular co-player they should also be more likely to act more prosocial when interacting with this person. This could be evidence for the fact, that empathy and vicarious emotions are essential for exhibiting prosocial behavior.

Material and Methods

In order to answer the aforementioned hypotheses, the study at hand used a controlled within-subjects experimental manipulation with realistic situations. Both state and trait behavioral measures as well as event-related fMRI were conducted to collect our data. The mentalizing task as well as the empathy and prosocial tasks took place in the MR-scanner and constituted the state behavioral measures. While the participants mentalized with the two target persons, rated their own and the perceived pain of the co-players and completed the prosocial task, their brain activity was recorded with the help of an MR-scanner and this data was analyzed afterwards. To obtain a trait behavioral measure of empathy, all participants filled out the IRI at the end of the experiment. The whole study was conducted as a one-time examination, so the participants had to show up just once for the fMRI-session.

Participants

The sample for the imaging study comprised a total of 32 female participants between the age of 18 and 32 years (mean age=22.5). They all had good German language skills, which was a necessary requirement in order for the priming task to work out. Moreover, our participants all were right-handed, had normal or corrected to normal sight and did not have medical, neurological or psychiatric problems. Additionally, all participants had to give written informed consent before taking part in the study. Excluded from the experiment were students of psychology because they could have too much knowledge or experience with testing situations. Furthermore we had to exclude participants who had metallic objects in their body or those who suffered from claustrophobia.

All participants were recruited via social networks as well as an online job fair (www.jobwohnen.at) and they were paid 25€ for participating in the study. The experiment lasted for about two hours and was carried out at the MR Centre of Excellence of the Vienna General Hospital. To obtain a more homogeneous sample, we recruited women only. Moreover, it is possible that men would exhibit protective instincts in the empathy task towards our two fictitious female co-players. To avoid this confounding variable, we did not recruit male participants. In addition, Bates and colleagues (1981) mention, that it is easier and more likely for participants to empathize with a same-sex co-player.

Prior to the actual imaging study we ran a pilot study to test if our experimental design worked out. Therefore, we recruited 30 participants (f=16; m=14) between the age of 18 and 40 (mean age=23.97). All participants were divided into two groups: one group, which carried out the mentalizing task and one group, which carried out a control task, in which visual perspective statements were used. The mentalizing group in the pilot study comprised a total of 24 participants and because the visual perspective group was just the control group, this one included only 6 participants. All of them had good German language skills and no medical, neurological or psychiatric conditions. The sample for the pilot study was recruited via social networks, www.jobwohnen.at and the online platform of a psychology course. They were paid 15€ for participating in the experiment and were tested without the MR-scanner at the psychological faculty of the University of Vienna. The payment of all participants in both the pilot and the imaging study could be implemented due to a scholarship, which we received from the University of Vienna.

Stimulus Material

Prior to the actual experimental tasks, we took a picture of the participant and pretended that there were also photos taken of the two fictitious co-players, which actually has already been done in advance. The pictures and videos of two fellow students, who served as the fictitious, red and blue co-players in the study, were taken prior to the study begin. We randomized the person and the color of the co-player, so that person A and B were half of the time shown as the red co-player and the other time they were depicted as the blue co-player. This procedure should assure, that possible effects do not occur due to a more likeable appearance of one co-player. All pictures showed the upper part of the body including the head and the hands. These pictures were used in the actual tasks for two reasons: first, the pictures helped the participants to recognize, whose turn it was and second, with the help of the pictures it should be easier for the participants to link the statements of the mentalizing task to the two co-players. Without the pictures, the tasks would have been too abstract and it would have been probably harder for the participants to put themselves in the position of the co-players. In addition to the pictures, we showed the participants a short and fake Skype connection in order to pretend that the two co-players were real and just sitting in different buildings.

Mentalizing I Task

The priming task in this study was divided into two parts, mentalizing I and mentalizing II. The aim of mentalizing I was to induce congruency or incongruity between the participant and the fictitious target persons while mentalizing II constituted the actual mentalizing process in which data about brain activation was collected. For that purpose, we developed statements about different mental states, including thoughts, preferences, intentions and desires, as well as statements concerning visual aspects of the participant's residence. The first ones were used in the mentalizing group, whereas the latter ones are going to be used in the visual perspective group, which should serve as a control group. However, the subject of this diploma thesis is only the experimental group, which did the mentalizing tasks. The visual perspective group should be investigated later on and therefore it is not part of the current thesis.

We developed a total of 133 pairs of statements, each consisting of two eligible options, for both conditions and conducted an online study to examine the distribution of the two options of each statement. A sample of 223 students (f=121; m=102; mean age=22.56) rated all of these statements, both mental and visual perspective-taking. Out of these 133 pairs we took those pairs of statements, of which both of the two options were similarly likely to be

chosen. On this basis, we chose the best 48 pairs of mental statements and 48 pairs of visual perspective-taking statements to be part of the priming in the actual imaging study. The statements for the mentalizing condition can be found in the appendix.

In the mentalizing I task, 24 pairs of statements were shown to the participants, concerning their thoughts, preferences, intentions and desires. Together with a picture of themselves, the participants saw two opposing statements at a time on the screen and had to decide, which statement would fit best for them. The picture and the statements were shown as long as the participant chose an option. Following, a yellow frame was shown around the chosen option for 4 seconds. The frame was yellow because the participant was the yellow co-player. After their decision, they saw a picture of either the red or the blue co-player, presumably choosing her preferred option, for 4 to 8 seconds on the screen. Subsequently, the two statements again were shown for 4 seconds with either a red or a blue square framing the chosen and therefore preferred option of the respective co-player. The time between the trials was 3.5 seconds. Our manipulation provided, that in 80% of the cases one fictitious co-player "chose" the same option as the participant preferred, while the other co-player "chose" the opposite statement. In this way, the participant should recognize, that one co-player was similar (= congruent) in terms of thoughts, preferences, intentions and desires and the other one was rather dissimilar (= incongruent) to her.

Mentalizing II Task

In the second part of the priming, which served as the actual mentalizing task, the participants were requested to put themselves in the position of their two co-players and considered their mental states. The participants had to guess, which of the two statements on the screen would fit best for the particular co-player. In this part of the priming there were also 24 pairs of statements to choose from, first on behalf of the co-player and at the end of the task for the participants themselves. In order to know, in whose position they should put themselves, the participants saw a picture of either the red or the blue co-player on the screen for 3.5 seconds. Afterwards, the two options of the statement appeared on the screen and remained until a response was given. The two options together with either a red or a blue frame around the chosen one stayed on the screen for another 2.5 seconds. The inter-trial time varied from 4 to 9 seconds in this part.

After estimating their co-players mental states, the participants had to answer the same items, which they answered before in behalf of their co-players, for themselves. This was done to check if the priming worked out and if the participants chose their preferred answer

for the congruent co-player more often than for the incongruent co-player. Again, a picture of the participant herself together with the two options of the statement was shown on the screen until an option was chosen. Following, the two options, with a frame around the chosen one, remained on the screen for 2.5 seconds. The inter-trial interval was variable from 3 to 7 seconds.

Both parts of the priming task took place in the MR-scanner. In this way there is no big pause between the priming and the actual task. Moreover, if the participants are doing the priming tasks already in the scanner, they are able to get used to the environment and the noises, which the scanner makes before they complete the actual empathy and prosociality tasks. As we are not interested in the brain activation during mentalizing I, we did not perform functional imaging measures while the participants completed the first part of the priming.

Empathy Task

In the empathy task, the participants received either painful or non-painful electrical stimulation on the back of their hands and it was pretended that their fictitious co-players received the same stimulation. The participants' task here was to rate their own sensations and to put themselves in the position of the co-player while rating their perceived sensations. In each trial either the participant, the red co-player or the blue co-player received a painful or a non-painful electrical stimulus. Before the stimulation was administered, a picture of the particular player, who was going to receive the electrical stimulus, was shown on the screen for 2.5 to 4 seconds. Afterwards, the participants got information about whether the upcoming stimulation is going to be painful or not: a colored flash on a grey square was projected onto the picture of the player for 1 second. Here, a blue flash signaled a non-painful stimulation whereas an orange flash announced a painful stimulation. As soon as the flash changed its color, the stimulation was administered. In case of a non-painful stimulation the blue flash turned green and stayed as long as the actual stimulation lasted. For the painful stimulation, the orange flash turned red and also stayed on the screen for the duration of the stimulation. In case of a self-trial, the red or green flash was accompanied by either a painful or a non-painful stimulation, which lasted for 1.5 seconds. Because the actual stimulation could not be seen live, the colored flashes were also helpful for the participants to imagine, how the other player would perceive the stimulation in order to empathize with her.

After some trials (three for each condition), the participants had to answer two types of questions. Either they had to rate their own sensations while they received electrical

stimulation themselves ("How painful was the stimulus for yourself?") or they had to rate the feelings they had while they were watching one of the fictitious co-players receiving electrical stimulation ("How unpleasant was it for you, to witness this stimulation?"). For their ratings the participants had a 7-point Likert scale ranging from "not at all" (-3) to "very" (3). The ratings of their feelings during the stimulation of the co-player should be an indicator for the degree of empathy, which the participants exhibited towards the two fictitious target persons. There were 90 trials in this task in total, whereby in 15 trials the participant got a non-painful stimulus and in 15 trials she got a painful one. In the remaining trials, either the red or the blue co-player received painful or non-painful stimuli. We collected ratings for 6 self-trials and for 6 trials of each co-player, whereby 3 of these six trials involved painful stimuli and the other 3 concerned non-painful stimuli. All in all, we collected data in 18 of the 90 trials. The rating screen remained until the desired answer was chosen. The time between the trials varied from 3.1 to 8.9 seconds in this task.

Prosocial Task

The last part of our study, the prosocial task, was designed as a gambling task. Here, the participants could split a total of 14 to 17 electrical stimuli between themselves and their co-players. In each trial they were playing against one of their fictitious co-players and both of them, the participant and the co-player, had to choose one of four geometric symbols, which differed in form and color. First, the "playing with" screen was shown, where the participant could see the picture of the particular co-player, against whom she was playing in this trial. The picture of the co-player stayed on the screen until the trial was finished. 4 seconds after this picture appeared, the four shapes were shown of which the participant could choose one. Shortly after choosing a symbol, the participant saw the symbol, which the particular co-player had chosen. This should generate the idea of a gambling task: if they chose they "right" symbol in the right time, they got the opportunity to decide about the distribution. If they chose the "wrong" one, it was either the co-player's or the computer's turn to decide. Subsequently, the total number of stimuli together with the notification, who is going to decide about the distribution, was shown on the screen for 5 seconds. Afterwards, the participant could see three possible distributions on the screen. These distributions varied in terms of prosociality. In the more prosocial distributions the participant accepted more stimuli for herself and less for the co-player she was playing with. In the more egoistic distributions the participant decided to get less electrical stimuli than the particular co-player. Sometimes there were also equal distributions, in which both the participant and the co-player received

the same amount of stimuli. Hence, in trials in which it was the participant's turn to decide, she had the possibility to either take off electrical stimuli from the co-player or pass on electrical stimuli to the co-player. The time, how long the three possible distributions lasted on the screen depended on who was deciding: if it was the participant's turn, the numbers remained until she chose an option. In case of the co-player's choice, the distributions lasted on the screen for 5 to 7.5 seconds and if the computer decided, the numbers disappeared after 2.5 seconds. In trials, in which the participant could decide, a screen saying "decision made" appeared together with a frame around the chosen distribution for 2.5 seconds. If the co-player or the computer decided, the "decision made" screen also appeared but the participant did not see their choices.

There were 36 trials in this task in total and the participant had to decide about the distribution of the stimuli in 16 of these trials: 8 of them concerned the congruent co-player and the other 8 involved the incongruent co-player. The sets of distributions were identical for both the congruent and the incongruent co-player and they only varied in the time, when they were presented in the task. The participants thought, that in the end of the task the computer would randomly choose one trial of this game and that the distribution of the electrical stimuli in this trial should be implemented. But this was just a pretext to get honest answers and keep the participants from deciding in a socially desirable way. After the task, we told the participants that we could not carry out this part of the experiment due to technical problems or a lack of time.

Afterwards, there was a short part in which the participants had to rate their two co-players in terms of sympathy, cooperativeness, familiarity, similarity and connectedness. They could indicate their answers on a 7-point Likert scale ranging from "not at all" (-3) to "very" (3). This was the last part carried out in the MR-scanner.

Experimental Procedure

Before the actual experiment started, the participants were informed about the procedure of the experiment and the tasks they had to complete. First, they got an information sheet about the most important details of the study and afterwards, a member of the scientific staff explained in a personal talk the sequence of the tasks and what the participant should pay attention on. After the instruction, a yellow cloth was handed to the participants, the stimulus electrode was attached on the back of their left hand and a photo was taken of them. Then we started the pain calibration to find their upper and lower thresholds for pain, which were needed for the empathy task. As every person has different thresholds for pain, the

participants had to indicate before the experiment started, which level of stimulation was noticeable but not unpleasant and which level was painful but bearable for them. The noticeable stimulus, which was not unpleasant, was administered for the non-painful condition and the painful stimulus, which was clearly painful but bearable in the course of some trials, was administered for the painful condition. Afterwards, we showed them the fake Skype connection with the two fictitious co-players to underpin our story, that these two were really somewhere in the surrounding buildings, doing the same experiment. Subsequently, the experiment in the MR-scanner began. First, the participants completed the two parts of the priming task inside the scanner. As we only examined the mentalizing group in the current study, all participants rated statements about their thoughts, intentions, preferences and beliefs. These statements were randomly presented over all participants to avoid effects of positioning. The goal of this priming task was to give the participants the impression, that one of the co-players was similar to themselves and the other co-player was rather dissimilar.

Afterwards, the empathy task started inside the scanner. The participants received electrical stimulation and they had to rate both their own sensations as well as the perceived sensations of the co-player. The last part of the experiment was the prosocial task, which was also carried out inside the scanner. In the end of the prosocial task we informed the participants either that there was not enough time to implement the additional stimuli or that our equipment is not working properly any more. Following, the participants completed the ratings of similarity, sympathy, familiarity, connectedness and cooperativeness for the two co-players. After this rating, the experiment inside the scanner was completed and the participants had to fill out a debriefing questionnaire and the German version of the IRI questionnaire outside the scanner. The IRI collects data on four subscales, which cover some aspects of the more global concept of empathy: perspective-taking, fantasy, empathic concern and personal distress (Davis, 1983). In the debriefing questionnaire, the participants were asked how they perceived the experiment and if they believed that their two co-players were real (see appendix for further information).

Analysis of Behavioral Data

In addition to the responses to the tasks, we also collected data about the exact time, when the participants pressed the button box. The timing of these button box presses was used to model the regressors for all further experimental analyses. The button responses, which we received during the mentalizing, empathy and prosocial tasks of the imaging study, were analyzed using SPSS 21 (IBM SPSS Statistics, New York, NY, USA). To obtain the effect of the

priming condition (congruent vs. incongruent) on empathy, we calculated a 2x2 repeated measurement ANOVA with the factors of "painfulness" (pain vs. no pain) and the factors of "condition" (congruent vs. incongruent). In addition, post-hoc tests were conducted to examine if the effect occurs for both painful and non-painful conditions or if it is just apparent in one condition. To check for the manipulation in the priming task, we compared the number of same statements with the congruent co-player and the amount of equal statements with the incongruent co-player in a paired t-Test. Examining the effects of the prosocial tasks, we conducted paired t-Tests for differences between the shocks that have been taken from the congruent co-player and the incongruent co-player, the ones that have been passed to the congruent and the incongruent co-player and the differences between the congruent and the incongruent co-player concerning the number of most prosocial and most egoistic option chosen. Furthermore, we conducted paired t-Tests for the differences between the ratings of sympathy, connectedness, familiarity, cooperativeness and similarity for the congruent and the incongruent co-player. For all analyses of behavioral data, we set the alpha level to 0.05.

MRI Acquisition

The acquisition of the MRI data happened with a 3 Tesla Siemens Tim Trio MRI system (Siemens Medical, Erlangen, Germany) and for reception of signal a 32-channel head coil was used. The blood oxygen level-dependent (BOLD) sensitive functional imaging was carried out using a fast multi-band echoplanar imaging (EPI) sequence with the following parameters: echo time (TE) = 34 ms, repetition time (TR) = 1300 ms, interleaved acquisition, flip angle 65°, field of view (FOV) = 192 mm x 192 mm x 115.15 mm, matrix size = 96 x 96, voxel size = 2.0 x 2.0 x 3.5 mm, 30 axial slices co-planar to the conjoining line between anterior and posterior commissure and interslice gap 10% (0.4mm). We acquired structural images after the functional scanning with the help of a magnetization-prepared rapid gradient-echo (MPRAGE) sequence (TE = 4.21ms, TR = 2300 ms, 160 sagittal slices, voxel size = 1.0 x1.0 x1.1 mm, FOV = 256 mm).

Analysis of MRI Data

SPM 8 (Statistical Parametric Mapping; http://www.fil.ion.ucl.ac.uk/spm/), carried out in Matlab 7.8 (The MathWorks Inc., Natick, MA, USA), was used to analyze the imaging data in the current study. To allow for T1 equilibration, we rejected the first five volumes of each participant and realigned the time series for each voxel temporally to the recording of the first slice in order to correct for differences in slice time acquisition (Sladky et al., 2011). We used

a sinc interpolation algorithm, which reduces head-movements between each image and a reference image in order to estimate rigid body transformations as for example translations and rotations, to spatially realign the image time series (Friston et al., 1995). Following, gray matter (GM), white matter (WM) and cerebral spinal fluid (CSF) tissue probability maps, which are available in SPM12, were used to segment each participant's functional image into GM, WM and CFS. Using both linear and nonlinear transformations, these tissues were spatially normalized to the International Consortium for Brain Mapping (ICBM) space templates (European brains). Subsequently, the functional images of each participant were spatially co-registered to the non-normalized structural images and additionally they were spatially normalized.

Within the context of the General Linear Model (GLM), we applied an event-related approach to analyze the fMRI time series. From the button responses, which were collected during the study, trial-by-trial measures of the timings of different portions of each trial were extracted. Subsequently, single-subject models were developed, consisting of a specific set of regressors for each task. For mentalizing II, regressors describing the following epochs were used: 1) photo stimulus indicating whose turn it was, 2) mentalizing with the congruent person, 3) mentalizing with the incongruent person, 4) presentation of the chosen statement for the co-players, 5) deciding about the statements for oneself and 6) the presentation of the self-chosen statement. For the single-subject model of the empathy task, regressors describing the following epochs were used: the waiting phase 1) for the participant, 2) for the congruent person, 3) for the incongruent person, the non-painful anticipation and stimulation 4) for the participant, 5) for the congruent person, 6) for the incongruent person, the painful anticipation and stimulation 7) for the participant, 8) for the congruent person, 9) for the incongruent person and 10) the ratings. For the prosocial task, seven regressors were used characterizing the following epochs: 1) the "playing with" screen, which announced with whom the participant is going to play, 2) the selection of the shape, 3) the screen, which displays who is going to decide, the participant's decision about the distribution 4) for the congruent person and 5) for the incongruent person, 6) the time period in which the participant waits for the decision of the computer or the co-player and 7) the "decision made" screen.

On a trial-by-trial basis, we created each effect as a combination of square-wave functions. To model the above-mentioned regressors, these square-wave functions were convolved with the aid of a canonical hemodynamic response function, as performed in SPM8 (Friston et al., 1995). We included the six rigid-body motion parameters (translation and rotation) in the model to account for the effects of head motion. To identify and label the

anatomical and Brodmann's area of the resulting clusters of activations, the SPM Anatomy Toolbox (Eickhoff et al., 2005) was used. Additionally, MRIcron (www.mricron.com) was applied to create images of the hemodynamic responses of different brain areas during our experimental manipulation.

Statistical Inference

To assess the statistical significance of the estimated evoked hemodynamic responses, a repeated measurement ANOVA and paired t-tests were used within the general linear model-based analyses. Specifically, we were interested in the effects that the congruency of the target persons has on the empathic response of the participants and the amount of prosocial behavior they exhibit towards the target persons.

The mentalizing task served to collect data about the brain activation during mentalizing with the congruent and the incongruent person. Paired t-tests with the factor „condition" (congruent vs. incongruent) were calculated, from which two conditions were yielded. The contrast estimates of these two conditions first were computed for each participant with respect to an implicitly modeled baseline. Afterwards, the emerged contrast images were included in a second-level analysis using paired t-tests, in which the following two contrasts were calculated: CONGRUENT PERSON > INCONGRUENT PERSON and INCONGRUENT PERSON > CONGRUENT PERSON.

In the empathy task we were specifically interested in assessing the effects of our experimental manipulation (mentalizing with persons with congruent vs. incongruent mental states) on brain activity immediately preceding and during the stimulation. We used a 2x3 design with the factors "painfulness" (pain vs. no pain) and "condition" (self vs. congruent co-player vs. incongruent co-player), which resulted in six conditions. For each participant we calculated the contrast estimates of these conditions with respect to an implicitly modeled baseline. The resulting six contrast images were then entered into a random-effects, second-level analysis using a within-subjects ANOVA, in which we calculated the following contrasts: CONGRUENT PAIN > INCONGRUENT PAIN, CONGRUENT > INCONGRUENT (collapsed over PAIN and NO PAIN) and EMPATHY PAIN > EMPATHY NO PAIN (collapsed over CONGRUENT and INCONGRUENT) as a general manipulation check. Additionally, the interaction contrast between the differences in brain activation in the contrast CONGRUENT PAIN > CONGRUENT NO PAIN and the activation differences in the contrast INCONGRUENT PAIN > INCONGRUENT NO PAIN was examined, resulting in the following contrast: (CONGRUENT PAIN > CONGRUENT NO PAIN) > (INCONGRUENT PAIN > INCONGRUENT NO PAIN). We masked

this contrast inclusively with the contrast CONGRUENT PAIN > CONGRUENT NO PAIN, to constrict our analysis to areas showing the effect in the direction of interest.

In the prosocial task, the intention was to examine the differences in brain activation while the participants divided electrical stimuli between themselves and the congruent co-player and the incongruent co-player, respectively. Again, paired t-tests were used with the factor "condition" (congruent vs. incongruent) and the two obtained conditions were then used to calculate the contrast estimates for each participant with respect to an implicitly modeled baseline. Subsequently, we inserted the two generated contrast images into a second-level analysis using paired t-tests and computed the following contrasts: CONGRUENT PERSON > INCONGRUENT PERSON and INCONGRUENT PERSON > CONGRUENT PERSON.

Besides the above-mentioned imaging analyses, we also conducted correlations between the signal in certain brain areas or the activation in the whole brain and the obtained behavioral data. For all statistical analyses, a threshold of $p = 0.05$ was used, corrected for multiple comparisons over the whole brain. In order to do so, the Gaussian random fields approach was used at a cluster-level and an intensity threshold of $p = 0.001$ at a voxel-level was applied (Friston et al., 1996).

Results

Behavioral Results

In the mentalizing task, the manipulation check showed a significant difference in the percentage of statements the participants had in common with the congruent and the incongruent co-player ($T(29) = 5.651$, $p < 0.001$; see figure 1; note that there are only 30 participants in this analysis due to technical problems during data acquisition). This finding indicates that our manipulation worked out and that the participants chose more often their preferred statement for the congruent co-player too.

More importantly, the behavioral analyses revealed a main effect of congruency in the empathy task ($F(31) = 7.261$, $p = 0.011$; see figure 2). Over both painful and non-painful conditions, the empathy ratings were higher for the congruent person in comparison to the incongruent person. In addition, the factor "painfulness" was significant too ($F(31) = 39.428$, $p < 0.001$), which shows that, clearly, the empathy ratings were higher in the painful condition in contrast to the non-painful one. Post-hoc tests showed that, separated for conditions of painfulness, the effect of congruency only persists in the non-painful condition ($T(31) = 2.527$, $p = 0.017$). Hence, the participants just differentiated between the congruent

and the incongruent co-player in the non-painful condition. In the painful condition, the empathy ratings for the congruent person did not significantly differ from the ratings for the incongruent person ($T(31) = 1.085$, $p = 0.286$).

We did not find any significant results in the analyses of the prosocial task. There was neither a significant difference in the number of stimulations taken from the congruent co-player and the ones taken from the incongruent co-player ($T(31) = -0.228$, $p = 0.821$) nor a significant difference between stimuli passed to the congruent and the incongruent co-player ($T(31) = 0.202$, $p = 0.841$). Furthermore, the number of times the most prosocial option was chosen ($T(31) = -0.841$, $p = 0.407$) and the number of times the most egoistic option was chosen ($T(31) = -0.516$, $p = 0.609$) did not differ significantly between the congruent and the incongruent target person. It can be concluded that the participants did not differentiate between the congruent and the incongruent co-player in the prosocial task. Overall, they chose more often the most egoistic decision ($m = 3.95$) than the most prosocial one ($m = 2.23$) regardless of whether they played against the congruent or the incongruent co-player.

However, our analyses revealed a significant correlation of medium strength between the overall empathy ratings for painful stimuli and the prosociality index ($r = 0.564$, $p = 0.001$). This index marks how often the most prosocial distribution rather than the least prosocial one was chosen.

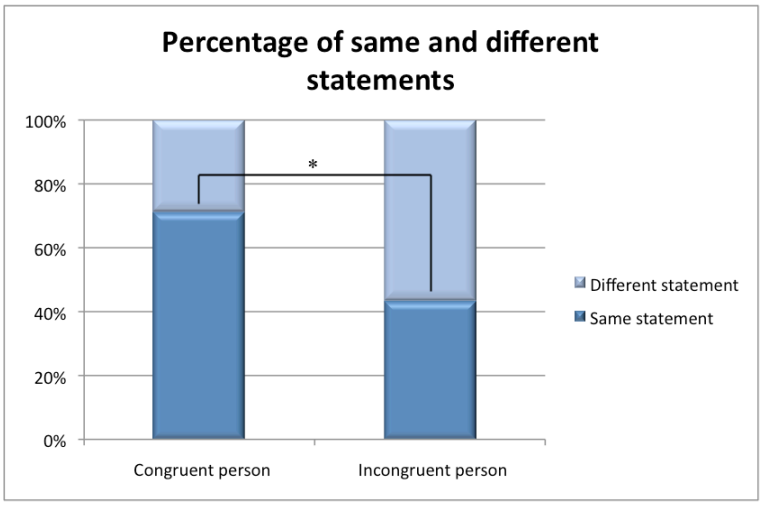

Figure 1: Percentage of how often the participants chose the same and the opposite of their preferred statement for the congruent and the incongruent co-player.

Further analyses showed a significant difference between the participants' ratings of the congruent and the incongruent co-player in terms of similarity ($T(31) = 9.009$, $p < 0.001$),

sympathy ($T(31) = 3.802$, $p = 0.001$), connectedness ($T(31) = 7.758$, $p < 0.001$), familiarity ($T(31) = 5.261$, $p < 0.001$) and cooperativeness ($T(31) = 2.388$, $p = 0.023$; see figure 3).

The data collected in the debriefing questionnaire indicated that 17 persons out of 29 participants (only 29 because three participants forgot to fill out the last page of the questionnaire) had no doubt that the two co-players were real, carrying out the same experiment in different buildings. This finding is not significant ($\chi^2(1) = 0.862$, $p = 0.353$) but still it shows that more than half of the participants believed our cover story, therefore acting like they were playing with two real persons.

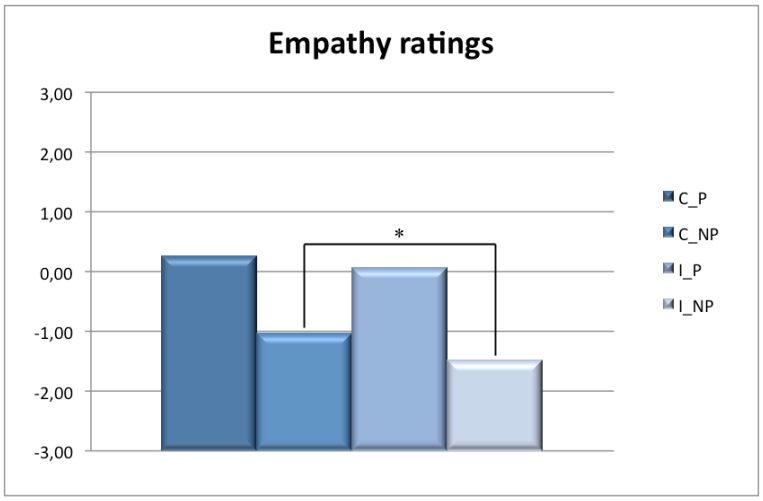

Figure 2: Empathy ratings for painful stimuli of the congruent person (C_P), non-painful stimuli of the congruent person (C_NP), painful stimuli of the incongruent person (I_P) and non-painful stimuli of the incongruent person (I_NP).

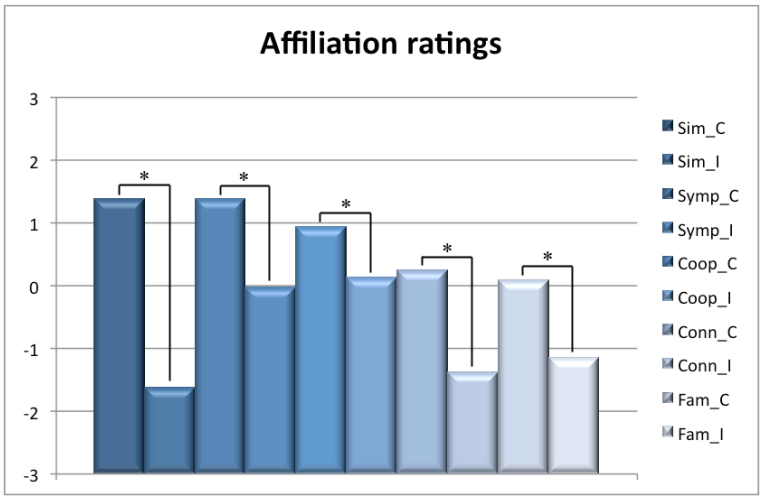

Figure 3: Ratings of similarity for the congruent (Sim_C) and incongruent (Sim_I) person, sympathy ratings for the congruent (Symp_C) and incongruent (Symp_I) person, cooperation ratings for the congruent (Coop_C) and incongruent (Coop_I) person, connectedness ratings for the congruent (Conn_C) and incongruent (Conn_I) person and familiarity ratings for the congruent (Fam_C) and incongruent (Fam_I) person.

fMRI Results

Mentalizing with congruent and incongruent persons

In the priming condition, the contrast CONGRUENT PERSON > INCONGRUENT PERSON did not yield a significant network of brain areas. In contrast, the reverse comparison INCONGRUENT PERSON > CONGRUENT PERSON revealed a significant difference of brain activation in the inferior frontal gyrus bilaterally (IFG; BA 46), which corresponds to the ventrolateral prefrontal cortex (VLPFC; Aron et al., 2004). Table 1 and figure 4 provide detailed information about these two clusters of activation, which seem to be more active while mentalizing with incongruent target persons compared to mentalizing with congruent persons. Due to technical problems during the acquisition of data, there are only 30 participants in these analyses of the mentalizing task.

Furthermore, we found a cluster above threshold in the right posterior parietal cortex (PPC)/angular gyrus (BA 7) when correlating the amount of differentiating in similarity ratings between the congruent and the incongruent target person with the whole brain activation in the mentalizing task for the contrast INCONGRUENT PERSON > CONGRUENT PERSON (see table 1 and figure 4 for more information). It seems to be, that the more the participants differentiate in the similarity ratings between the congruent and the incongruent co-player, the more activation is exhibited in this area.

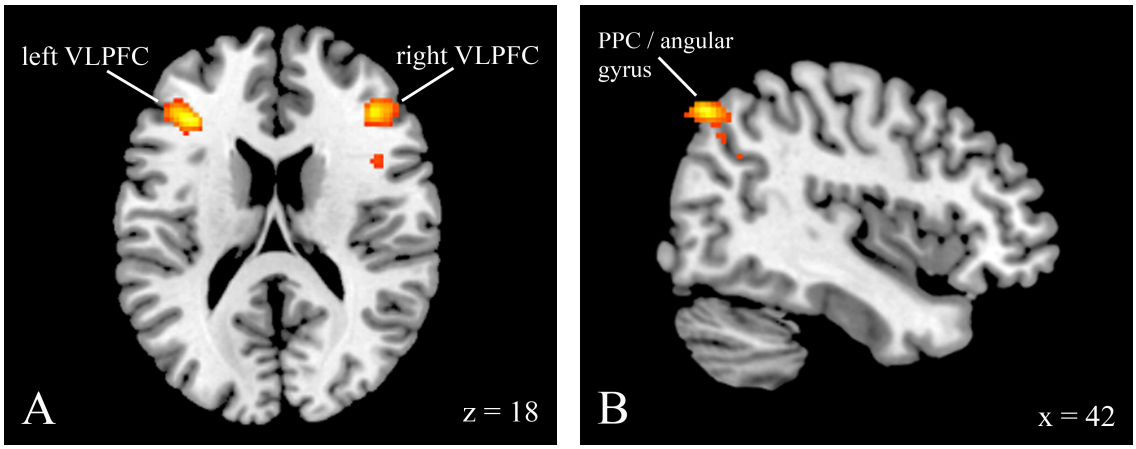

Figure 1: Statistical parametric maps (SPMs) yielding increased hemodynamic response (A) during mentalizing with incongruent in contrast to congruent persons and (B) during correlating the activation while mentalizing with incongruent in contrast to congruent persons with differentiating in similarity ratings for congruent and incongruent persons. (A) bilateral ventrolateral prefrontal cortex (VLPFC) (B) right posterior parietal cortex (PPC)/angular gyrus. According to the neurological convention of using the structural MRI template, which is available in SPM8, the displayed SPMs were created, using a threshold of p= 0.05 and a cluster-level-correction for multiple comparisons.

Table 1: Summary of the MNI stereotactic coordinates displaying the local maxima of the activation clusters which were obtained in the imaging analyses concerning the activation differences in mentalizing with incongruent and congruent target persons, the empathy-related activation during the rating of painful and non-painful conditions, the correlation between the activation in mentalizing and the differentiation in similarity ratings, as well as the interaction contrast in empathy-related activation.

Area	Hemisphere	Peak MNI-coordinates x y z	Cluster size (voxels)	T-Value	P-value (corrected)
Activation during mentalizing with incongruent vs. congruent target persons					
IFG | VLPFC	right	38 30 14	539	5.45	0.000
IFG | VLPFC	left	-36 30 18	296	5.52	0.001
Empathy-related activation in painful vs. non-painful conditions					
Precuneus	left	-8 -64 36	402	5.72	0.000
aMCC	right	10 12 56	1174	5.19	0.000
AI	left	-30 20 2	853	4.91	0.000
MFG	left	-34 4 50	270	4.77	0.006
TPJ	left	-58 -44 32	1895	4.60	0.000
TPJ	right	66 -36 22	322	4.22	0.002
AI	right	34 24 2	275	4.16	0.005
Correlation between similarity ratings and mentalizing activation					
PPC | angular gyrus	right	40 -74 50	240	5.19	0.003
Interaction contrast in empathy-related activation					
TPJ	left	-54 -56 30	274	4.60	0.006

IFG = inferior frontal gyrus; VLPFC = ventrolateral prefrontal cortex; aMCC = anterior midcingulate cortex; AI = anterior insula; MFG = middle frontal gyrus; TPJ = temporoparietal junction; PPC = posterior parietal cortex

Empathy-related activation for congruent vs. incongruent persons

The contrast PAIN > NO PAIN (collapsed over congruent and incongruent target persons) in the empathy task, which served as a manipulation check, showed activation in a large network of expected brain areas, which includes the following clusters: anterior insula bilaterally (AI), the anterior part of the midcingulate cortex (aMCC) and adjacent rostral cingulate zone (RCZ), the precuneus, the temporoparietal junction bilaterally (TPJ) and the left middle

frontal gyrus (MFG; BA 6). More information about the significant clusters can be found in table 1 and figure 5. Testing for the more important contrast CONGRUENT PAIN > INCONGRUENT PAIN did not reveal any clusters above threshold, suggesting that there was no significant difference between empathizing with the congruent co-player and empathizing with the incongruent one.

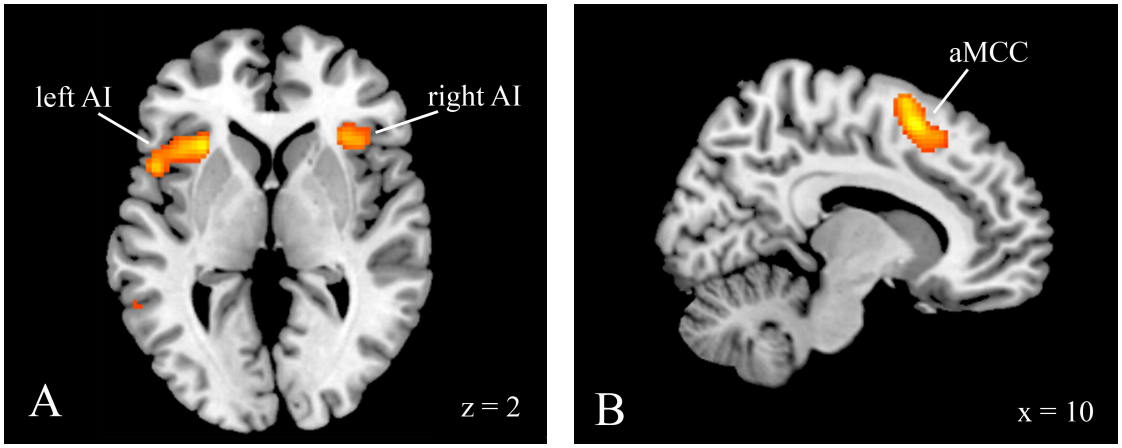

Figure 2: SPMs demonstrating increased activation in the manipulation contrast PAIN > NO PAIN during the empathy task. (A) bilateral anterior insula (B) right anterior midcingulate cortex (aMCC). For further specifications, see Figure 4.

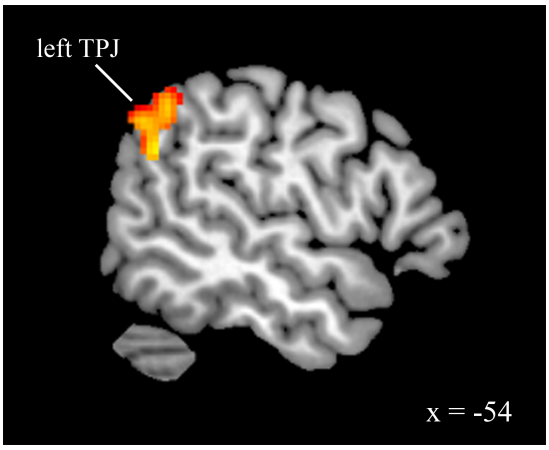

Figure 3: SPM displaying the increased hemodynamic response during the interaction contrast, which contrasts the differences in brain activation for the congruent person during painful and non-painful stimuli with the differences in the activation pattern for the incongruent person during painful and non-painful stimuli. This interaction contrast yields increased activation in the left temporoparietal junction (TPJ). More specifications can be found in Figure 4.

The interaction contrast (CONGRUENT PAIN > CONGRUENT NO PAIN) > (INCONGRUENT PAIN > INCONGRUENT NO PAIN), masked inclusively with the contrast CONGRUENT PAIN > CONGRUENT NO PAIN to isolate the differences in brain activation for the congruent person

between painful and non-painful stimuli that exceeded the differences in brain activation for the incongruent person between painful and non-painful stimuli, revealed a cluster above threshold in the left temporoparietal junction (TPJ; BA 40; see table 1 and figure 6).

Prosocial behavior towards congruent vs. incongruent persons

For the analyses of the prosocial task, we had a look at both the contrast CONGRUENT PERSON > INCONGRUENT PERSON as well as on the contrast INCONGRUENT PERSON > CONGRUENT PERSON. Unfortunately, neither the first nor the latter contrast yielded any significant brain clusters, which suggests that the participants did not differentiate in the prosocial task between the congruent and the incongruent co-player.

Discussion

The main goal of our study was to shed light on the link between mentalizing and prosocial behavior as well as the connection between mentalizing and empathy, which both could have been shown in previous studies. The idea was to extend previous findings in terms of congruency and examine if the effects of mentalizing just occur in congruent conditions, in which the target person mentalized with shows the same thoughts, desires, intentions and preferences as the participant does. In this way it should have been clarified, if reflecting on mental states of other people increases empathy and prosocial behavior towards them. In addition, we wanted to figure out if the effects, which mentalizing has on prosocial behavior, are mediated through the level of empathy felt towards the particular target person. To do so, we conducted an online group experiment with two fictitious co-players during which both fMRI and behavioral data was collected. First, we induced similarity and dissimilarity towards the two fictitious co-players in the priming task and afterwards, we let the participants rate the perceived pain of the fictitious target persons. Additionally, the participants completed a prosocial task, in which they could take electrical stimuli off from the target persons or pass the stimuli on to them.

Implications of mentalizing with congruent and incongruent target persons

The experimental manipulation in the mentalizing task worked out insofar, that the participants chose more often their preferred statement to be also more appropriate for the congruent person, showing that they perceived one of the co-players to be similar to themselves and the other one to be rather the opposite of them when it comes to mental states. This is also underlined by the finding of significant differences in the affiliation ratings for the

congruent and the incongruent person. Overall, the congruent co-player was perceived to be more similar, familiar, sympathetic, cooperative and the participants felt more connected to the congruent person compared to the incongruent one, suggesting that our experimental manipulation led to a higher extent of identification with the person, who seems to have more commonalities with the participant in terms of thoughts, desires, intentions and preferences.

Examining the differences in brain activation during mentalizing with the congruent person and mentalizing with the incongruent person did not reveal any significant clusters of activation in the contrast CONGRUENT PERSON > INCONGRUENT PERSON. We could not find differences in the activation pattern in different subregions of the mPFC in this contrast. Previous studies have found that the ventral mPFC is involved when mentalizing with similar persons whereas the dorsal mPFC shows more activation when mentalizing with dissimilar others (Mitchell et al., 2006), but unfortunately, neither the first nor the latter area exhibited significant differences between mentalizing with the congruent and the incongruent person. Interestingly, we found a difference in the brain activation pattern the other way round. Comparing the brain activation during mentalizing with the incongruent person and mentalizing with the congruent one, yielded significant clusters of activation in the VLPFC bilaterally. In the literature, the VLPFC is linked to response uncertainty (Levy & Wagner, 2011) and response inhibition (Ridderinkhof et al., 2004). Levy and Wagner (2010) suggest, that response uncertainty especially is linked to activity in the right mid-VLPFC, but that there is an influence of the type of stimuli used in the experiment on the lateralization of the activation: while the left VLPFC is activated by verbal stimuli, the activation in the right VLPFC is related to visuo-spatial stimuli. When both verbal and non-verbal processing is involved in the task, e.g. by using pictures of persons or objects, that are easy to name, bilateral activation of the VLPFC is recorded (Kelley et al., 1998). In response uncertainty tasks, there is a high extent of ambiguity because both eligible answer options are equiprobable to be chosen and it has to be determined, which behavior is currently important (Levy & Wagner, 2011). Our results suggest, that it is more difficult for the participants and needs more effort to put themselves into the position of the incongruent co-player, who seems to have not much in common with them. In the present study, the participants had to decide between two options and select that statement, which would, in their opinion, fit best for their co-player. Due to the information they obtained in the first part of the mentalizing, the participants recognized that one target person had not much in common with them in regard of their mental states, which probably could have increased the ambiguity in the trials concerning the incongruent person. This uncertainty might stem from the fact that the

participants could not easily rely on using themselves as a template for inferring the incongruent player's mental states. Hence, the increased ambiguity in the trials, which involved the incongruent person, could account for the activation in the VLPFC bilaterally when mentalizing with the incongruent co-player in contrast to mentalizing with the congruent co-player. We suggest, that because pictures of the co-players, which are easy to recode, were used in this task, the activation in the VLPFC was found bilaterally.

Furthermore, activation in the VLPFC is observed in response inhibition tasks (Aron et al., 2004). Response inhibition is the cognitive process that leads to the suppression of intended impulses and actions (Garavan et al., 1999; Aron et al., 2004). Studies have shown, that the right VLPFC exhibits activation in tasks, which involve cancelling of intended answer tendencies and that, generally, response inhibition predominantly recruits the right hemisphere (Garavan et al., 1999; Aron et al., 2003). In the present study, bilateral activation of the VLPFC was found solely in incongruent vs. congruent trials. This suggests that, in case of the incongruent co-player, the participants had to inhibit their first intention of choosing their own preferred statement in order to select the opposite statement for the incongruent co-player. In these trials, the participants could not use themselves as an appropriate template and project their own mental states onto the incongruent co-player because this target person did not seem similar enough for this simulation process to work out. The participants rather had to inhibit the intention of using themselves as a reference in order to be able to choose the proper statement for the dissimilar person. Therefore, the inhibition of the first intuitively reaction and the updating of the action plan in order to select the appropriate answer for the incongruent co-player could account for the activation found in bilateral VLPFC in the current study.

Additionally, correlating the mentalizing activation in the contrast INCONGRUENT > CONGRUENT with the differentiation in similarity ratings between the congruent and the incongruent co-player revealed a significant cluster of activation in the right PPC/angular gyrus. The PPC is not only known to be related to episodic memory retrieval (Wagner et al., 2005), it also has been shown that activation in the right posterior superior parietal cortex is more activated in doubt-related trials in contrast to high-confidence ones (Moritz et al., 2006; Kim & Cabeza, 2009). As shown in the affiliation ratings, the incongruent person was perceived to be more dissimilar to the participant. We assume, that due to this circumstance there was a higher extent of uncertainty and doubt, respectively, in trials involving the incongruent co-player, which made it more difficult for the participants to pick the appropriate statement in behalf of the incongruent co-player. Since the congruent co-player

was perceived as being more similar to the participant, these trials involved less uncertainty and were characterized by more confidence to choose the appropriate statement for this co-player. According to these findings we conclude, that mentalizing with the incongruent, dissimilar person is more difficult than mentalizing with the congruent, similar person, because it involves a high extent of uncertainty and the participants are unsure, which option to pick for the incongruent co-player, thus probably inhibiting their first, intuitive guess.

Empathizing with congruent and incongruent target persons

The behavioral results of the empathy task revealed an effect of congruency on empathy ratings, which is driven by the non-painful condition. It has been shown, that the participants differentiated significantly between the congruent and the incongruent target person in their empathy ratings for non-painful stimuli. The co-player with similar mental states received higher empathy ratings for the non-painful stimulus. Thus, it appears to be easier for the participants to put themselves in the position of the congruent co-player and to empathize with their non-painful sensations. In contrast, the participants experienced less empathy when the incongruent person was exposed to the non-painful stimulus. This finding shows, that the congruency of mental states has an influence on the empathy rating of non-painful electrical stimuli. In the painful condition, the participants did not discriminate in their empathy ratings between the two target persons. It seems to be, that our female participants perceived pain as being painful, regardless who is experiencing this painful stimulus and apart from similarity or dissimilarity between this target person and themselves. Moreover, collapsed over the congruent and the incongruent person, the painful stimuli received higher empathy ratings than the non-painful stimuli did, indicating that the manipulation and the technical equipment worked out and the participants perceived the non-painful stimuli to be more bearable and not as painful as the painful ones. It can be concluded, that the behavioral data analyzed in the current study confirms our initial assumption that the similarity of mental states has an influence on empathy, even when this effect is driven by non-painful trials.

Comparing painful with non-painful trials in the empathy task yielded brain activation in the expected network of brain areas, which includes the anterior insula bilateral, the aMCC, the left precuneus, the TPJ bilateral and the left MFG. Thus, it can be concluded, that the experimental manipulation worked out and the areas, which are involved in the pain-network (Peyron et al., 2000), exhibited activation during the anticipation and imagination of both the congruent and the incongruent co-player's perceived pain in contrast to the non-painful stimuli. The analyses of the brain activation during empathizing with the congruent and the

incongruent target person did not yield any significant cluster of brain activation, neither for painful stimuli only nor for painful and non-painful stimuli combined and regardless of the direction of the contrast (CONGRUENT PERSON > INCONGRUENT PERSON and INCONGRUENT PERSON > CONGRUENT PERSON). There were no differences in the extent of activation or in the recruiting of brain areas while empathizing with the congruent person in contrast to empathizing with the incongruent person, and vice versa.

However, when contrasting the differences in the brain activation during CONGRUENT PAIN > CONGRUENT NO PAIN with the differences in the activation pattern during INCONGRUENT PAIN > INCONGRUENT NO PAIN and masking it inclusively with the contrast CONGRUENT PAIN > CONGRUENT NO PAIN, a significant cluster of activation in the left TPJ was obtained. The TPJ is involved in both mentalizing and distinguishing the self from the other, which is a crucial factor for social interactions (Frith & Frith, 2003; Saxe & Kanwisher, 2003; Decety & Lamm, 2007; Decety & Sommerville, 2003). According to Uddin and colleagues (2006), the TPJ has two functions: it builds up shared representations of the self and the other and it helps to discriminate between them. This self-other distinction is necessary for the attribution of mental states (Brass et al., 2009). There is a tight connection between the representation of our own thoughts and the thoughts of another person, recruiting the same brain areas and resulting in an overlap between processing of the self and the other person (Decety & Sommerville, 2003). This is also emphasized by the fact that self-related judgments as well as other-related judgments activate common brain regions, including the TPJ (Denny et al., 2012).

The results in the current study suggest, that the priming with similar and dissimilar mental states did not influence the activation of different brain areas while empathizing with the congruent and the incongruent target person. Thus, in terms of brain activation, we have to reject our hypothesis that congruent and incongruent mental states of target persons mentalized with influence the extent of empathy, which participants feel towards them. A possible explanation for this finding could be that the participants nevertheless did discriminate between the congruent and the incongruent target person in the empathy task and there were differences in brain activation between empathizing with the two of them, but they were maybe to subtle for fMRI to detect them. However, the present study also shows, that the TPJ exhibits more activation when differentiating between the congruent person's painful and non-painful stimuli in contrast to distinguishing between the painful and non-painful stimuli, to which the incongruent person was exposed to. Brass and colleagues (2009) argue that, after the occurrence of similarity between the self and the other, distinction processes

have to take place in order to discriminate the representation of the self from the one of the other. One has to overcome his or her own perspective to be able to put oneself in the position of another person. In the study at hand it seems to be that these distinction processes are more elaborated in the case of empathizing with the congruent person, therefore leading to higher activation in the left TPJ. Due to the greater similarity felt towards the congruent person there seems to be more need for the participants to actively disengage themselves from the distress of the other person, probably in order to not being overwhelmed by the extent of empathy which they feel towards the congruent person due to greater merging with her.

Prosocial behavior exhibited towards congruent and incongruent target persons

We assumed in the present study, that the participants would exhibit a higher amount of prosocial behavior when they interact with a target person, who is similar to them in terms of mental states. Vice versa, they would demonstrate less prosocial behavior in interaction with the incongruent person. Hence, it was hypothesized, that the participants take off more electrical stimuli from the congruent co-player and therefore reduce the amount of painful stimuli the congruent person will receive in the end and pass more electrical stimuli on to the incongruent co-player, increasing her amount of painful stimuli. Unfortunately, we did not find any behavioral differences in the prosocial behavior exhibited towards congruent and incongruent target persons in our study. The participants did not differentiate between the two co-players, regardless if they rated one of them to be similar to themselves. This can also be observed in the analyses of the imaging data, which did not yield any significant clusters of brain activation while discriminating between the congruent and the incongruent target person. Besides, the participants acted more egoistically than prosocially over both conditions, indicating that they avoided getting more electrical stimuli than necessary. It seems that the participants did not see any need to act prosocially in this task, because in the end everyone is going to receive electrical stimuli, one person more, the other one less. For future research, we should try to adapt this task in order to obtain better results and to clarify the link between similarity of mental states and prosocial behavior. Apparently, our task did not encourage the participants enough to act more prosocial and take a greater amount of electrical stimuli off their congruent co-players. However, our data revealed a correlation of medium strength between the overall ratings for painful stimuli, collapsed over the congruent and incongruent person, and the prosociality index, which marks the number of times, how often the most prosocial distribution is chosen rather than the least prosocial one. This finding suggests, that the participants' empathy towards the target persons somehow is connected to

their prosocial behavior: the higher the participants rated the painful stimuli, the more often they preferred the most prosocial distribution rather than the least prosocial one. Nevertheless, this link does not seem to be strong enough to cause effects of the congruency manipulation on prosocial behavior. Even if the empathy ratings for the congruent person were significantly higher in the non-painful condition, this circumstance did not have any effect on the prosocial behavior towards the congruent target person. In the current study, we could not find any evidence for our hypotheses that similarity of mental states influences prosocial behavior exhibited towards the congruent target person and that empathy mediates these effects. For future studies we suggest to favor a less explicit task for examining prosocial behavior. Even if we had a not negligible number of measurements in the prosocial task of this study, it seemed to be easy for the participants to remember, how they distributed the electrical stimuli between themselves and each co-player, therefore choosing the same distributions in trials with the other co-player. Thus, the participants apparently tried to balance the number of electrical stimuli given to each of the target persons. Probably, the lack of any finding in the prosocial task is linked to social desirability, which means that the participants acted in a way, of which they thought would be appropriate. Even if they preferred one co-player they did not want to seem unfair by favoring her, therefore they distributed the electrical stimuli as fair as possible over both co-players. If the participants are forced to choose one co-player, who they can favor by taking off electrical stimuli from him or her, they choose more often the congruent co-player (Maksimova, 2014). Therefore, it is noted that the design of the prosocial task should be changed in future research.

For future studies we would also suggest, to try a between-subjects design instead of the within-subject design used in this study. It is possible that the participants were cognitively overloaded by having to pay attention to two different co-players: they had to focus on two of them and keep in mind information about both. Maybe it would be easier if the participants in such a design would just have one co-player on whom they could concentrate on, therefore causing more conclusive results. An alternative explanation for this suggestion is, that the change in prosocial behavior, which has been found in most of the other studies, was probably a change of the participants' prosociality in general and was not constrained to specific persons. If this is the case, one cannot find results in a within-subject design like the study at hand used.

Conclusion

We have demonstrated in the current study, that mentalizing with similar persons has a behavioral effect on empathy, which is driven by non-painful stimuli. This finding suggests, that participants empathize more with target persons, who have similar mental states compared to themselves, at least when it comes to non-painful sensations. Interestingly, we did not detect any effect of mentalizing on empathy in the imaging data. Furthermore, our data could account for the assumption that mentalizing with dissimilar persons seems to be more difficult than mentalizing with similar persons. When mentalizing with dissimilar persons, bilateral clusters in the VLPFC show increased activation, indicating that there is a higher extent of ambiguity in trials, which involve the incongruent person. This leads to more uncertainty on the part of the participants and probably to the inhibition of their first and intuitive guess in order to pick the appropriate statement for the incongruent co-player. Our results reveal evidence for the application of the simulation theory: the uncertainty, which has been found in trials concerning the incongruent person, indicates that a certain similarity has to be crucial for mentalizing with others. When mentalizing with the congruent person, the participants seemed to use themselves as a reference and projected their own mental states onto the congruent co-player in order to pick the proper statement. In trials, which involved the incongruent person, a simulation was not expedient because the participants recognized that they were not similar enough to function as an appropriate template for inferring the mental states of this target person.

Nevertheless, mentalizing with similar and dissimilar persons did not reveal any effect, neither behavioral nor visibly in brain activation, on prosocial behavior in the present study. It is suggested, to revise the prosocial task in future studies, probably designing it as a less explicit task in which the participants will not be able to react in a socially desirable way.

References

Ames, D. R. (2004). Inside the mind reader's tool kit: projection and stereotyping in mental state inference. *J Pers Soc Psychol, 87*(3), 340-353.

Amodio, D. M., & Frith, C. D. (2006). Meeting of minds: the medial frontal cortex and social cognition. *Nat Rev Neurosci, 7*(4), 268-277.

Aron, A. R., Fletcher, P. C., Bullmore, E. T., Sahakian, B. J., & Robbins, T. W. (2003). Stop-signal inhibition disrupted by damage to right inferior frontal gyrus in humans. *Nat Neurosci, 6*(2), 115-116.

Aron, A. R., Robbins, T. W., & Poldrack, R. A. (2004). Inhibition and the right inferior frontal cortex. *Trends Cogn Sci, 8*(4), 170-177.

Atique, B., Erb, M., Gharabaghi, A., Grodd, W. & Anders, S. (2011). Task-specific activity and connectivity within the mentalizing network during emotion and intention mentalizing. *Neuroimage, 55*, 1899–1911.

Batson, C.D., Duncan, B.D., Ackerman P., Buckley, T., & Birch, K. (1981). Is Empathic Emotion a Source of Altruistic Motivation? *J Pers Soc Psychol, 40*(2), 290-302.

Batson, C.D., Fultz, J., & Schoenrade, P.A. (1987). Distress and Empathy: Two Qualitatively Distinct Vicarious Emotions with Different Motivational Consequences. *J Pers, 55*, 19–39.

Batson, C.D., & Powell, A.A. (2003). Altruism and Prosocial Behavior. In T. Millon & M.J. Lerner (Eds.) *Handbook of Psychology* (Vol. 5, pp. 463-484). Wiley & Sons, New Jersey.

Brass, M., Ruby, P., & Spengler, S. (2009). Inhibition of imitative behaviour and social cognition. *Philos Trans R Soc Lond B Biol Sci, 364*(1528), 2359-2367.

Brief, A.P., & Motowidlo, S.J. (1986). Prosocial Organizational Behaviors. *Academy of Management Review, 11*(4), 710-725.

Carruthers, P., & Smith, P.K. (Eds., 1996). *Theories of Theories of Mind.* Cambridge Univ Press, Cambridge.

Ciaramelli, E., Bernardi, F., & Moscovitch, M. (2013). Individualized Theory of Mind (iToM): When Memory Modulates Empathy. *Front Psychol, 4*, 4.

Contreras, J. M., Schirmer, J., Banaji, M. R., & Mitchell, J. P. (2013). Common brain regions with distinct patterns of neural responses during mentalizing about groups and individuals. *J Cogn Neurosci, 25*(9), 1406-1417.

Davis, M.H. (1983). Measuring Individual Differences in Empathy: Evidence for a Multidimensional Approach. *J Pers Soc Psychol, 44*(1), 113-126.

Decety, J. (2011). The neuroevolution of empathy. *Ann N Y Acad Sci, 1231*, 35-45.

Decety, J., Echols, S., & Correll, J. (2009). The Blame Game: The Effect of Responsibility and Social Stigma on Empathy for Pain. *J Cogn Neurosci, 22*(5), 985–997.

Decety, J., & Lamm, C. (2007). The role of the right temporoparietal junction in social interaction: how low-level computational processes contribute to meta-cognition. *Neuroscientist, 13*(6), 580-593.

Decety, J., & Sommerville, J.A. (2003). Shared representations between self and other: a social cognitive neuroscience view. *Trends Cogn Sci, 7*(12), 527-533.

Denny, B. T., Kober, H., Wager, T. D., & Ochsner, K. N. (2012). A meta-analysis of functional neuroimaging studies of self- and other judgments reveals a spatial gradient for mentalizing in medial prefrontal cortex. *J Cogn Neurosci, 24*(8), 1742-1752.

de Vignemont, F., & Singer, T. (2006). The empathic brain: how, when and why? *Trends Cogn Sci, 10*(10), 435-441.

de Waal, F. B. (2008). Putting the altruism back into altruism: the evolution of empathy. *Annu Rev Psychol, 59*, 279-300.

Dumontheil, I., Kuster, O., Apperly, I. A., & Blakemore, S. J. (2010). Taking perspective into account in a communicative task. *Neuroimage, 52*(4), 1574-1583.

Eickhoff, S.B., Stephan, K.E., Mohlberg, H., Grefkes, C., Fink, G.R., Amunts, K., & Zilles, K. (2005). A new SPM toolbox for combining probabilistic cytoarchitectonic maps and functional imaging data. *Neuroimage, 25*, 1325–1335.

Eisenberg N. (2007). Empathy-related responding and prosocial behaviour. *Novartis Found Symp, 278*, 71-80.

Eisenberg, N., Fabes, R.A., & Spinrad, T.L. (2006). Prosocial Development. In N. Eisenberg, W. Damon, R. M. Lerner (Eds.), *Handbook of Child Psychology, Vol. 3: Social, Emotional, and Personality Development* (6th edition, pp. 646-718). New Jersey: Wiley & Sons.

Friston, K.J., Holmes, A.P., Worsley, K.J., Poline, J.-P., Frith, C.D., & Frackowiak, R.S.J. (1995). Statistical Parametric Maps in Functional Imaging: A General Linear Approach. *Hum Brain Mapp, 2*, 189-210.

Friston, K.J., Holmes, A., Poline, J.-B., Price, C.J., & Frith, C.D. (1996). Detecting Activations in PET and fMRI: Levels of Inference and Power. *Neuroimage, 4*, 223-235.

Frith, C. D., & Frith, U. (1999). Interacting Minds--A Biological Basis. *Science, 286*(5445), 1692-1695.

Frith, U., & Frith, C. D. (2003). Development and neurophysiology of mentalizing. *Philos Trans R Soc Lond B Biol Sci, 358*(1431), 459-473.

Frith U., Morton, J., & Leslie, A.M. (1991). The cognitive basis of a biological disorder: autism. *Trends in Neurosciences, 14*(10), 433-438.

Gallagher, H. L., & Frith, C. (2003). Functional imaging of 'theory of mind'. *Trends Cogn Sci, 7*(2), 77-83.

Gallese, V. (2003). The manifold nature of interpersonal relations: the quest for a common mechanism. *Philos Trans R Soc Lond B Biol Sci, 358*(1431), 517-528.

Gallese, V., & Goldman, A. (1998). Mirror neurons and the simulation theory of mind-reading. *Trends Cogn Sci, 2*(12), 493-501.

Garavan, H., Ross, T.J., & Stein, E.A. (1999). Right hemispheric dominane of inhibitory control: An event-related functional MRI study. *Proc Natl Acad Sci USA, 96*, 8301-8306.

Goldman, A.I. (1992). Empathy, Mind, and Morals. *Proc Address Am Philos Assoc, 66*(3), 17-41.

Goldman, A.I. (2006). *Simulating Minds. The Philosophy, Psychology, and Neuroscience of Mindreading.* New York: Oxford University Press.

Hein, G., Lamm, C., Brodbeck, C., & Singer, T. (2011). Skin conductance response to the pain of others predicts later costly helping. *PLoS One, 6*(8), e22759.

Hein, G., & Singer, T. (2008). I feel how you feel but not always: the empathic brain and its modulation. *Curr Opin Neurobiol, 18*(2), 153-158.

Hodges, S. D., & Wegner, D. M. (1997). Automatic and controlled empathy. In W. Ickes (Ed.), *Empathic accuracy* (pp. 311-339). New York: Guilford.

Jackson, P. L., Meltzoff, A. N., & Decety, J. (2005). How do we perceive the pain of others? A window into the neural processes involved in empathy. *Neuroimage, 24*(3), 771-779.

Kelley, W.M., Miezin, F.M., McDermott, K.B., Buckner, R.L., Raichle, M.E., Cohen, N.J., Ollinger, J.M., Akbudak, E., Conturo, T.E., Snyder, A.Z., & Petersen, S.E. (1998). Hemispheric Specialization in Human Dorsal Frontal Cortex and Medial Temporal Lobe for Verbal and Nonverbal Memory Encoding. *Neuron, 20,* 927-936.

Kim, H., & Cabeza, R. (2009). Common and specific brain regions in high- versus low-confidence recognition memory. *Brain Res, 1282*, 103-113.

Lamm, C., Batson, C.D., & Decety, J. (2007). The Neural Substrate of Human Empathy: Effects of Perspective-taking and Cognitive Appraisal. *J Cogn Neurosci, 19*(1), 42-58.

Levy, B. J., & Wagner, A. D. (2011). Cognitive control and right ventrolateral prefrontal cortex: reflexive reorienting, motor inhibition, and action updating. *Ann N Y Acad Sci, 1224*, 40-62.

Majdandzic, J., Bauer, H., Windischberger, C., Moser, E., Engl, E., & Lamm, C. (2012). The human factor: behavioral and neural correlates of humanized perception in moral decision making. *PLoS One, 7*(10), e47698.

Maksimova, M. (2014), Like Me – The Influence of Movement Congruency and Contingency on Empathy and Prosocial Behavior, unpublished final degree thesis, University of Vienna, Vienna.

Mitchell, J.P. (2008). Contributions of Functional Neuroimaging to the Study of Social Cognition. *Curr Dir Psychol Sci, 17*(2), 142-146.

Mitchell, J.P., Banaji, M.R., & Macrae, C.N. (2005). The Link between Social Cognition and Self-referential Thought in the Medial Prefrontal Cortex. *J Cogn Neurosci, 17*(8), 1306-1315.

Mitchell, J. P., Macrae, C. N., & Banaji, M. R. (2006). Dissociable medial prefrontal contributions to judgments of similar and dissimilar others. *Neuron, 50*(4), 655-663.

Moritz, S., Glascher, J., Sommer, T., Buchel, C., & Braus, D. F. (2006). Neural correlates of memory confidence. *Neuroimage, 33*(4), 1188-1193.

Peyron, R., Laurent, B., & García-Larrea, L. (2000). Functional imaging of brain responses to pain. A review and meta-analysis, *Neurophysiol Clin, 30*, 263-288.

Preston, S. D., & Hofelich, A. J. (2012). The Many Faces of Empathy: Parsing Empathic Phenomena through a Proximate, Dynamic-Systems View of Representing the Other in the Self. *Emotion Review, 4*(1), 24-33.

Ridderinkhof, K. R., van den Wildenberg, W. P., Segalowitz, S. J., & Carter, C. S. (2004). Neurocognitive mechanisms of cognitive control: the role of prefrontal cortex in action selection, response inhibition, performance monitoring, and reward-based learning. *Brain Cogn, 56*(2), 129-140.

Saxe, R. (2006). Why and how to study Theory of Mind with fMRI. *Brain Res, 1079*(1), 57-65.

Saxe, R., & Kanwisher, N. (2003). People thinking about thinking people The role of the temporo-parietal junction in "theory of mind". *Neuroimage, 19*(4), 1835-1842.

Singer, T., Seymour, B., O'Doherty, J., Kaube, H., Dolan, R.J., & Frith, C.D. (2004). Empathy for pain involves the affective but not sensory components of pain. *Science, 303*(5661), 1157-1162.

Singer, T., Seymour, B., O'Doherty, J. P., Stephan, K. E., Dolan, R. J., & Frith, C. D. (2006). Empathic neural responses are modulated by the perceived fairness of others. *Nature, 439*(7075), 466-469.

Sladky, R., Friston, K. J., Trostl, J., Cunnington, R., Moser, E., & Windischberger, C. (2011). Slice-timing effects and their correction in functional MRI. *Neuroimage, 58*(2), 588-594.

Tomasello, M. (2006). *Die kulturelle Entwicklung des menschlichen Denkens*. Frankfurt am Main: Suhrkamp.

Uddin, L. Q., Molnar-Szakacs, I., Zaidel, E., & Iacoboni, M. (2006). rTMS to the right inferior parietal lobule disrupts self-other discrimination. *Soc Cogn Affect Neurosci, 1*(1), 65-71.

Völlm, B. A., Taylor, A. N., Richardson, P., Corcoran, R., Stirling, J., McKie, S., Deakin, J. F. W., & Elliott, R. (2006). Neuronal correlates of theory of mind and empathy: a functional magnetic resonance imaging study in a nonverbal task. *Neuroimage, 29*(1), 90-98.

Wagner, A. D., Shannon, B. J., Kahn, I., & Buckner, R. L. (2005). Parietal lobe contributions to episodic memory retrieval. *Trends Cogn Sci, 9*(9), 445-453.

Waytz, A., & Young, L. (2012). The group-member mind trade-off: attributing mind to groups versus group members. *Psychol Sci, 23*(1), 77-85.

Waytz, A., Zaki, J., & Mitchell, J. P. (2012). Response of dorsomedial prefrontal cortex predicts altruistic behavior. *J Neurosci, 32*(22), 7646-7650.

Zaki, J., & Ochsner, K. N. (2012). The neuroscience of empathy: progress, pitfalls and promise. *Nat Neurosci, 15*(5), 675-680.

Tables and Figures

List of tables

List of figures

Appendix

Abstract (German)

Der Simulations-Theorie zufolge benutzen Menschen sich selbst als eine Vorlage, um auf die mentalen Zustände von anderen zu schließen. Daher sollte es einfacher sein, mit Menschen zu mentalisieren, die uns ähnlicher sind. Die aktuelle Studie versuchte den Mechanismus zu klären, der hinter dem Zusammenhang zwischen Mentalisieren und prosozialem Verhalten steht: ist es die wahrgenommene Ähnlichkeit der Zielperson, die einen Einfluss darauf hat, dass mehr prosoziales Verhalten und höhere Empathiewerte gezeigt werden, oder ist es die größere Bekanntheit bzw. Vertrautheit, die durch das Priming zu den Zielpersonen hergestellt wurde. Mit Hilfe von fMRI wurde der Einfluss von kongruenten und inkongruenten mentalen Zuständen zweier fiktiver Zielpersonen auf die Empathie und das prosoziale Verhalten der Studienteilnehmerinnen untersucht. Das Herbeiführen von Kongruenz wurde dabei mittels ähnlicher und unähnlicher mentaler Zustände in einer Primingaufgabe durchgeführt, welche vor den eigentlichen Aufgaben bearbeitet wurde. Unsere Analysen ergaben gesteigerte Aktivierung im ventrolateralen präfrontalen Kortex (VLPFC) beim Mentalisieren mit unähnlichen Personen, darauf hindeutend, dass in diesen Durchgängen ein höherer Grad an Unsicherheit herrscht und dadurch die Studienteilnehmerinnen ihren ersten Impuls unterdrücken müssen, um die gegenteilige Aussage für die inkongruente Zielperson zu wählen. Weiters konnte gezeigt werden, dass kongruente mentale Zustände von Zielpersonen einen Einfluss auf die Empathie haben, die ihnen gegenüber gezeigt wird. Dieser Effekt wird dabei von nicht-schmerzhaften Reizen angetrieben. Die bildgebenden Daten zeigten keine Aktivierungsunterschiede in Arealen, die typisch für Empathie wären, aber es konnte erhöhte Aktivierung im linken temporoparietalen Übergang (TPJ) beim Mentalisieren mit der kongruenten Person gefunden werden. Es scheint, dass sich die Studienteilnehmerinnen aufgrund der empfundenen Ähnlichkeit aktiver von der kongruenten Person abgrenzen müssen, um möglicherweise nicht von der verspürten Empathie überwältigt zu werden, welche sich durch die größere Verschmelzung mit der kongruenten Person ergibt. Des Weiteren sind die Ergebnisse ein Anzeichen dafür, dass es schwieriger ist, mit unähnlichen Zielpersonen zu mentalisieren. In Bezug auf prosoziales Verhalten konnte in der vorliegenden Studie allerdings kein Effekt von Ähnlichkeit auf die Entscheidungen in der prosozialen Aufgabe gefunden werden.

Mentalizing statements

1. Ich mag die Lebendigkeit und Vielfalt der Großstadt mehr als das Leben am Land. – Ich mag die Gemütlichkeit und Natur am Land mehr als das Leben in der Großstadt.
2. Ich mag Katzen eher als Hunde: ich finde sie kuscheliger und mir gefällt, dass sie das machen, was sie wollen. – Ich mag Hunde eher als Katzen: ich finde sie treuer und mehr auf den Menschen bezogen.
3. Ich finde Tattoos etwas Schönes und ganz Persönliches und könnte mir gut vorstellen, mich tätowieren zu lassen. – Ich finde, dass Tattoos den Körper verunstalten und würde mich daher nie tätowieren lassen.
4. Ich mache lieber Urlaub am Strand, weil ich mich entspannen und dem Alltag entfliehen will. – Ich mache lieber Fernreisen, weil ich gerne fremde Menschen und Kulturen kennenlernen will.
5. Wenn das Wetter sehr heiß ist, bin ich gerne draußen und genieße die Hitze und die Sonne. – Wenn das Wetter sehr heiß ist, bin ich gerne im Kühlen und schütze mich vor der Hitze.
6. Ich mag Häuser mit kräftigen Farben, da diese originell und lebendig auf mich wirken. – Ich mag Häuser mit dezenten Farben, da diese unaufdringlich und zeitlos auf mich wirken.
7. Ich mag Eis mit Schokoladengeschmack, weil ich den Geschmack aromatisch finde. – Ich mag Eis mit Fruchtgeschmack, weil ich den Geschmack erfrischend finde.
8. Ich mag Sportarten, die Geschicklichkeit, Technik und Erfindungsgabe von mir erfordern. – Ich mag Sportarten, die Kraft, Ausdauer und Willensstärke von mir erfordern.
9. Klassische Möbel wirken oft muffig und langweilig auf mich. - Moderne Möbel wirken oft seelenlos und kalt auf mich.
10. Ich sehe mir gerne Filme an, die mich zum Lachen bringen. – Ich sehe mir gerne Filme an, die mich zum Nachdenken bringen.
11. Mir gefällt moderne Kunst, da ich es spannend finde, die Wirklichkeit auf eine andere Weise zu betrachten. – Mir gefällt klassische Kunst, da ich eine genaue Abbildung der Wirklichkeit am schönsten finde.
12. Ich würde eher ein Jahr als Astronaut auf dem Mars verbringen als ein Jahr in einem U-Boot: im Weltall ist es zwar einsam, aber viel spannender. – Ich würde eher ein Jahr in einem U-Boot verbringen als ein Jahr als Astronaut auf dem Mars: unter Wasser ist es vielleicht langweiliger, aber auch weniger riskant.
13. Ich mag es eher, in einem grünen Außenbezirk zu wohnen, weil mir gefällt, dass man dort sein eigenes Reich hat und über genügend Platz verfügt. – Ich mag es eher, in einer Wohnung in der Innenstadt zu wohnen, weil ich von dort schnell in die Stadt gelange und mir die Lebendigkeit gefällt.
14. Ich denke in Bildern und sehe Verbindungen visuell vor mir. – Ich denke in Sprache und beschreibe in meinem Kopf Verbindungen mit Worten.
15. Ich beschäftige mich gerne mit realistischen, praktischen Dingen. – Ich beschäftige mich gerne mit Theorien, Konzepten, Gedanken und Ideen.
16. Ich mache mir gerne To-Do Listen. – Ich erledige Aufgaben so, wie sie auftreten.
17. In der Schule haben mir die sprachlichen Fächer besser gefallen, weil ich da mein Sprachgefühl einbringen konnte. – In der Schule haben mir die naturwissenschaftlichen Fächer besser gefallen, weil ich dabei mein logisches Denken anwenden konnte.

18. Ich fälle gerne klare Entscheidungen. – Ich halte mir lieber alle Möglichkeiten offen.
19. Es fällt mir leichter, mich mündlich auszudrücken: da kann ich direkter sagen, was ich mir denke. – Es fällt mir leichter, mich schriftlich auszudrücken: da habe ich mehr Zeit, um meine Gedanken zu ordnen.
20. Ich komme nicht klar mit Besserwissern, weil es mich ärgert, wenn jemand immer Recht haben muss. – Ich komme nicht klar mit Pessimisten, weil es mich stört, wenn jemand alles schlecht und negativ macht.
21. Im Alltag mache ich gerne Pausen, um wieder neue Energie zu bekommen. – Für Pausen nehme ich mir im Alltag wenig Zeit; ich bin lieber schneller mit der Arbeit fertig.
22. Mit schweren Aufgaben beginne ich eher früh, weil ich am Ende keinen Stress haben will. – Mit schweren Aufgaben beginne ich eher spät, weil ich den Druck brauche.
23. Wenn mir die neue Frisur eines Freundes/einer Freundin nicht gefällt, fällt es mir eher schwer, etwas Positives aber Unwahres darüber zu sagen. – Wenn mir die neue Frisur eines Freundes/einer Freundin nicht gefällt, fällt es mir eher schwer, etwas Ehrliches aber Negatives darüber zu sagen.
24. Ich mag es, viel Verantwortung im Leben zu haben. - Ich mag es, möglichst frei von Pflichten zu sein.
25. Ich würde nicht gerne ohne Geschirrspüler leben, da mich Geschirr spülen einfach nervt. - Ich kann ohne Geschirrspüler leben, weil ich Geschirr spülen nicht unangenehm finde.
26. Beim Kauf von Geschenken plane ich bereits vor dem Einkauf, was ich gerne schenken möchte und verbringe möglichst wenig Zeit in Geschäften. – Beim Kauf von Geschenken gehe ich gerne durch verschiedene Geschäfte und lasse mich inspirieren.
27. Ich würde nicht gerne ohne Kaffeemaschine leben, da ich sehr gerne Kaffee trinke. - Ich kann gut ohne Kaffeemaschine leben, weil ich nicht so gerne Kaffee trinke.
28. Ich bin besser darin, mich mit Hilfe meines Gedächtnisses zu orientieren. - Ich bin besser darin, mich mit Hilfe von Kartenlesen zu orientieren.
29. Ich könnte mir vorstellen, etwas ganz anderes zu studieren bzw. beruflich zu machen. – Ich könnte mir auf keinen Fall vorstellen, etwas ganz anderes zu studieren bzw. beruflich zu machen.
30. Ich könnte mir gut vorstellen einen Zwilling zu haben, da es bestimmt lustig ist, wenn man sich so ähnlich ist und sich deshalb im Anderen wiedererkennen kann. - Ich kann mir nicht vorstellen einen Zwilling zu haben, da ich lieber einzigartig bin und nicht ständig verwechselt werden möchte.
31. Wenn ich alleine zuhause bin, koche ich nicht gerne: es ist mir zu viel Aufwand und ich denke, ein schnelles Gericht kann auch gesund sein. - Auch wenn ich alleine zuhause bin, koche ich gerne: es macht mir Spaß und mir ist wichtig, gesund zu essen.
32. Ich möchte in meiner Freizeit mehr Zeit zum Entspannen einplanen. – Ich möchte in meiner Freizeit mehr aufregende Aktivitäten einplanen.
33. Wenn ich Kinder habe, möchte ich in ihrer Erziehung mehr Wert auf Disziplin legen, als meine Eltern das taten. – Wenn ich Kinder habe, möchte ich in der Erziehung nachgiebiger sein, als es meine Eltern bei mir waren.
34. Die Chance ist groß, dass ich einmal meine eigene Firma gründen werde, weil ich einen Unternehmergeist besitze. – Ich werde wahrscheinlich nie eine eigene Firma gründen, weil ich nicht so viel Verantwortung tragen will.

35. Ich wünsche mir manchmal, in der Arbeit/im Studium mehr gefordert zu werden. – Ich wünsche mir manchmal, in der Arbeit/im Studium weniger gefordert zu werden.
36. Ich würde meinen Hobbys und dem Sport gerne mehr Zeit widmen (als derzeit). – Ich würde meiner Familie und meinen Freunden gerne mehr Zeit widmen (als derzeit).
37. Ich wünsche mir oft mehr Geduld. – Ich wünsche mir oft mehr Entscheidungsfähigkeit.
38. Wenn ich viel Geld gewinnen würde, würde ich mir ein schönes Haus kaufen, um dadurch mein Leben längerfristig angenehmer zu gestalten. – Wenn ich viel Geld gewinnen würde, würde ich eine ganz lange Reise machen, um dadurch etwas Unvergessliches zu erleben.
39. Ich hätte gerne etwas mehr Freizeit, um Dinge zu tun, die mir Spaß machen. – Ich hätte gerne etwas mehr Geld, um Dinge zu tun, die mir Spaß machen.
40. Ich würde gerne einmal mit Delfinen schwimmen, weil mich diese anmutigen und intelligenten Tiere faszinieren. – Ich würde gerne einmal einen Fallschirmsprung machen, weil mir ein freier Fall aus einer großen Höhe sehr aufregend erscheint.
41. Ich würde gerne einmal Tiefseetauchen, weil mich die Tier- und Pflanzenvielfalt des Meeresgrundes fasziniert. – Ich würde gerne einmal Höhlenklettern, weil mich das Klettern durch bizarre Welten aus unterirdischen Felsgebilden fasziniert.
42. Ich mache gerne Urlaub in den Bergen, weil ich die Aussicht und körperliche Anstrengung mag. – Ich verbringe gerne Urlaub am Meer, weil mich das Meer beruhigt und ich die Wärme mag.
43. Ich wünsche mir oft mehr Beständigkeit. – Ich wünsche mir oft mehr Abwechslung.
44. Ich wäre gerne entschlossener. – Ich wäre gerne spontaner.
45. Wenn ich mich für eine Zeitreise entscheiden müsste, würde ich gerne im Jahr 1965 leben, weil ich bei Ereignissen wie der ersten Mondlandung gerne live dabei gewesen wäre. – Wenn ich mich für eine Zeitreise entscheiden müsste, würde ich gerne im Jahr 2065 leben, weil ich gerne wissen würde, wie sehr sich die Welt bis dahin verändert hat.
46. Ich mag es, wenn im Winter die Raumtemperatur zum Arbeiten eher wärmer eingestellt ist: ich finde es dann behaglich und lauschig. – Ich mag es, wenn im Winter die Raumtemperatur zum Arbeiten eher kühler eingestellt ist: mit ein wenig frischer Luft kann ich besser nachdenken.
47. Wenn es im Fernsehen ein wichtiges Fußballspiel gibt, schaue ich es mir immer an: ich finde Fußball eine spannende Sportart. – Wenn es im Fernsehen ein wichtiges Fußballspiel gibt, mache ich lieber etwas anderes als es mir anzusehen: ich verstehe das große Interesse für Fußball nicht.
48. Wenn ich mich frei entscheiden könnte, würde ich mir ein großes Auto kaufen, da es mir wichtig ist, dass ein Auto stabil und geräumig ist. – Wenn ich mich frei entscheiden könnte, würde ich mir ein kleines Auto kaufen, da es mir wichtig ist, dass ein Auto sparsam und wendig ist.

Debriefing Questionnaire

universität wien

SCAN-Unit
Faculty of Psychology

Versuchspersonennummer: _____
Farbe: **GELB**

Liebe(r) TeilnehmerIn,

Vielen Dank, dass Sie an unserem Experiment teilgenommen haben!
Ihre Meinung ist uns sehr wichtig. Deshalb bitten wir Sie, sich noch kurz Zeit zu nehmen, um ein paar Fragen zu beantworten.
Bitte antworten Sie ehrlich und spontan, es ist uns wichtig zu wissen, was Sie über das Experiment denken, wie Ihre Eindrücke waren, welche Kritikpunkte Sie haben. Durch Ihre Mithilfe können wir das Experiment weiter optimieren.

1. Was war, Ihrer Meinung nach, der Zweck der Studie; die Fragestellung, die verfolgt wurde?

_____
_____
_____
_____

A. <u>Fragen über die Kennenlern-Aufgabe</u>

2. Ist Ihnen in dem Kennenlernspiel etwas Besonderes aufgefallen (z.B. an den Antworten, die Ihre MitspielerInnen gegeben haben)? Wenn ja, was genau ist Ihnen aufgefallen, und bei welcher/m der beiden MitspielerInnen (rot oder blau?)

_____
_____
_____
_____

B. <u>Fragen über die Aufgabe zur Personeneinschätzung</u>

3. a. Wie schwierig fanden Sie diese Aufgabe? Hatten Sie das Gefühl, die Entscheidungen Ihrer MitspielerInnen gut einschätzen zu können?

_____
_____
_____
_____

b. Wie haben Sie Ihre Entscheidungen in dieser Aufgabe getroffen? Gab es ein System, nach welchem Sie entschieden haben, welche Alternative besser auf Ihre/n jeweilige/n MitspielerIn zutreffen könnte, oder haben Sie intuitiv entschieden?

C. Fragen über die Schmerzbeurteilungsaufgabe

4. Wie schmerzhaft fanden Sie die eigenen Stimulationsreize? Waren diese gut erträglich oder ist es Ihnen schwer gefallen die Schmerzen auszuhalten?

5. a. Wie leicht oder schwer ist es Ihnen gefallen Ihre Gefühle in Bezug auf die eigenen Stimulationsreize zu bewerten?

   b. Wie leicht oder schwer ist es Ihnen gefallen zu beurteilen wie schmerzhaft die Stimulationsreize für Ihre MitspielerInnen waren?

   c. Wie leicht oder schwer ist es Ihnen gefallen Ihre eigene Gefühle während der Stimulation Ihrer MitspielerInnen zu bewerten?

6. a. Wie leicht oder schwer ist es Ihnen gefallen, sich in Ihre MitspielerInnen hineinzuversetzen während diese einen Stimulationsreiz erhielten?

   b. Ist dies Ihnen bei einem/r der beiden MitspielerInnen leichter bzw. schwerer gefallen? Wenn ja, bei welchem/r SpielerIn (rot oder blau) und warum?

D. Fragen über das Glücksspiel

7. Wie haben Sie die Aufgabe erlebt, in dem Sie die Schmerzreize zwischen Ihnen und den anderen MitspielerInnen aufteilen konnten? Ist Ihnen das leicht oder schwer gefallen?

8. Haben Sie bei der Verteilung der Schmerzreize zwischen Ihnen und den anderen MitspielerInnen nach einem System entschieden? Bitte kreuzen Sie jeweils die Antwort an, die am meisten zutrifft:

   a. Durchgänge in denen Sie mit de/m **roten MitspielerIn** spielten:

      ☐ Ich habe möglichst gut auf eine Gleichverteilung zwischen mir und dieser/m SpielerIn geachtet, weil

      ☐ Ich hatte die Tendenz dieser/m SpielerIn mehr Schmerzreize als mir selbst zuzuweisen, weil

      ☐ Ich hatte die Tendenz mir selbst mehr Schmerzreize als dieser/m SpielerIn zuzuweisen, weil

      ☐ Ich hab völlig willkürlich entschieden.

   b. Durchgänge in denen Sie mit de/m **blauen MitspielerIn** spielten:

      ☐ Ich habe möglichst gut auf eine Gleichverteilung zwischen mir und dieser/m SpielerIn geachtet, weil

      ☐ Ich hatte die Tendenz dieser/m SpielerIn mehr Schmerzreize als mir selbst zuzuweisen, weil

      ☐ Ich hatte die Tendenz mir selbst mehr Schmerzreize als dieser/m SpielerIn zuzuweisen, weil

☐ Ich hab völlig willkürlich entschieden.

9. Haben Sie bei dieser Aufgabe eine/n der beiden MitspielerInnen bevorzugt behandelt? Wenn ja, welche/r SpielerIn war das (rot oder blau) und warum?

10. Ihrem eigenen Eindruck entsprechend, wie schwer ist es Ihnen und Ihren MitspielerInnen gefallen, die Schmerzen (während der gesamten Stimulationsaufgabe) auszuhalten? Bitte kreuzen Sie Ihre Antwort auf den unten stehenden Skalen an (links entspricht „gar nicht schwer“, rechts entspricht „sehr schwer“).

Ich

gar nicht schwer auszuhalten	☐	☐	☐	☐	☐	☐	☐	☐	☐	sehr schwer auszuhalten

Rote/r MitspielerIn

gar nicht schwer auszuhalten	☐	☐	☐	☐	☐	☐	☐	☐	☐	sehr schwer auszuhalten

Blaue/r MitspielerIn

gar nicht schwer auszuhalten	☐	☐	☐	☐	☐	☐	☐	☐	☐	sehr schwer auszuhalten

E. Fragen über die zweite Schmerzbeurteilungsaufgabe

11. Wie haben Sie die zweite Schmerzbeurteilungsaufgabe, in denen Sie und die anderen Spieler die im Glücksspiel bestimmte Anzahl von weiteren Schmerzreizen erhielten, erlebt?

F. Allgemeine Fragen zum Versuchsablauf:

12. Wir hatten überlegt, alle TeilnehmerInnen in den Scannerraum zu setzen, haben uns aber aus Gründen der Anonymität dazu entschieden, sie in separaten Räumen unterzubringen.

    a. Wären Sie auch bereit gewesen an dem Experiment teilzunehmen wenn alle TeilnehmerInnen in demselben Raum gesessen wären, und Sie also nicht anonym wären?

b. Meinen Sie, es hätte Sie in irgendeinem der Tasks beeinflusst, wenn Sie mit den anderen in demselben Raum gesessen wären? Wenn ja, wie?

c. Da die anderen TeilnehmerInnen nicht im selben Raum waren wie Sie, hatten Sie jemals Zweifel, ob es die anderen wirklich gibt bzw. ob die online Interaktion echt war? Wenn ja, wie stark war der Zweifel?

13. Ist Ihnen an dem Versuchsablauf sonst etwas Ungewöhnliches aufgefallen?

Vielen Dank für Ihre Teilnahme!

Curriculum Vitae

Sandra Amashaufer

Personal Details:

Date of birth:	01.07.1988
Address:	Kendl 6, 3254 Bergland, Austria
E-mail:	sandra.amashaufer@gmx.at

Education:

08/11 – 12/11	Semester abroad at the University of Illinois at Urbana-Champaign (USA)
10/08 – present	Studies of psychology at the University of Vienna
09/06 – 06/08	Studies of psychotherapy at the Sigmund Freud Private University
09/98 – 06/06	Bundesgymnasium und Bundesrealgymnasium Wieselburg
09/94 – 06/98	Elementary school Petzenkirchen

Work Experience:

07/12	Participation at the 4th IASSIDD Europe Congress in Vienna
07/12 – 08/12	Regional Hospital Mostviertel Amstetten-Mauer Department of forensic psychiatry
04/08	Therapy Center Ybbs
09/07 – 02/08	'die moewe' Child Protection Agencies
08/07	Wagner Jauregg Psychiatric Clinic Linz
01/07	Psychosomatic Center Waldviertel

Languages:

Proficient in German and English

6 years French at school

3 years Italian at school

Qualifications:

Propädeutikum of psychotherapy

Good computer skills (MS Office, SPSS, Adobe CS3, Internet)

Drivers license B