

Mentaliseringslitteratur: Neurobiologi och neuropsykologi

Normaltillstånd

Forskning

- **[Fulltext via länk]** Assaf, M., Kahn, I., Pearlson, G. D., Johnson, M. R., Yeshurun, Y., Calhoun, V. D., & Hendler, T. (2009). [Brain activity dissociates mentalization from motivation during an interpersonal competitive game](#). *Brain Imaging and Behavior*, 3, 24-37.

Abstract

Studies demonstrating selective brain networks subserving motivation and mentalization (i.e. attributing states of mind to others) during social interactions have not investigated their mutual independence. We report the results of two fMRI studies using a competitive game requiring players to use implicit 'on-line' mentalization simultaneously with motivational processes of gains and losses in playing against a human or a computer opponent. We delineate a network, consisting of bilateral temporoparietal junction, temporal pole (TP), medial prefrontal cortex (MPFC) and right fusiform gyrus, which is sensitive to the opponent's response (challenging>not challenging the player) and opponent type (human>computer). This network is similar to a known explicit 'off-line' mentalization circuit, suggesting its additional involvement in implicit 'on-line' mentalization simultaneously with motivational processes of gains and losses in playing against a human or a computer opponent. We delineate a network, consisting of bilateral temporoparietal junction, temporal pole (TP), medial prefrontal cortex (MPFC) and right fusiform gyrus, which is sensitive to the opponent's response (challenging>not challenging the player) and opponent type (human>computer). This network is similar to a known explicit 'off-line' mentalization circuit, suggesting its additional involvement in implicit's response (challenging>not challenging the player) and opponent type (human>computer). This network is similar to a known explicit 'off-line' mentalization circuit, suggesting its additional involvement in implicit 'off-line' mentalization circuit, suggesting its additional involvement in implicit 'on-line' mentalization, a process more applicable to real-life social interactions. Importantly, only MPFC and TP were selective to mentalization compared to motivation, highlighting their specific operation in attributing states of mind to others during social interactions.

- Carrion, R. E., Keenan, J. P., & Sebanz, N. (2010). [A truth that's told with bad intent: An ERP study of deception](#). *Cognition*, 114, 105-110.

Abstract

Human social cognition critically relies on the ability to deceive others. However, the cognitive and neural underpinnings of deception are still poorly understood. Why does lying place increased demands on cognitive control? The present study investigated whether cognitive control processes during deception are recruited due to the need to inhibit a tendency to state the truth, or reflect deceptive intent more generally. We engaged participants in a face-to-face interaction game and examined event-related brain potentials (ERPs) while participants lied and told the truth with or without deceptive intention. The same medial frontal negative deflection (N450) occurred when participants lied and when they told the truth with deceptive intent. This suggests that the main challenge of lying is not to inhibit a tendency to state the truth. Rather, the challenge is to handle the cognitive conflict resulting from the need to keep others' mental states in mind while deceiving them.

- Cohen, M. X., David, N., Vogeley, K., & Elger, C. E. (2009). [Gamma-band activity in the human superior temporal sulcus during mentalizing from nonverbal social cues](#). *Psychophysiology*, 46,

43-51.

Abstract

The posterior superior temporal sulcus (pSTS) is a key structure for our ability to infer others' mental states based on social cues including facial expressions, body posture, and gestures ("mentalizing"), but the neural mechanisms of this ability remain largely unknown. We recorded electrocorticogram directly from the pSTS in humans to show that enhanced neural oscillations in the gamma frequency range (35–55 Hz) accompany mentalizing. One patient with a lesion in pSTS was tested behaviorally on this task; he was unable to infer a virtual character's preferences from nonverbal social cues. Enhanced coherent gamma oscillations in the patients with intact pSTS may reflect a process by which social signals are bound into a unified representation to support mentalizing. This may be relevant for other social cognitive processes, as well as to the study of autism spectrum disorders, for which both mentalizing deficits and abnormal gamma activity have been reported.

- **[Fulltext via länk]** David, N., Aumann, C., Santos, N. S., Bewernick, B. H., Eickhoff, S. B., Newen, A., et al. (2008). [Differential involvement of the posterior temporal cortex in mentalizing but not perspective taking](#). *Social Cognitive and Affective Neuroscience*, 3, 279-289.

Abstract

Understanding and predicting other people's mental states and behavior are important prerequisites for social interactions. The capacity to attribute mental states such as desires, thoughts or intentions to oneself or others is referred to as mentalizing. The right posterior temporal cortex at the temporal–parietal junction has been associated with mentalizing but also with taking someone else's spatial perspective onto the world possibly an important prerequisite for mentalizing. Here, we directly compared the neural correlates of mentalizing and perspective taking using the same stimulus material. We found significantly increased neural activity in the right posterior segment of the superior temporal sulcus only during mentalizing but not perspective taking. Our data further clarify the role of the posterior temporal cortex in social cognition by showing that it is involved in processing information from socially salient visual cues in situations that require the inference about other people's mental states.

- Decety, J., Michalska, K. J., & Akitsuki, Y. (2008). [Who caused the pain? An fMRI investigation of empathy and intentionality in children](#). *Neuropsychologia*, 46, 2607-2614.

Abstract

When we attend to other people in pain, the neural circuits underpinning the processing of first-hand experience of pain are activated in the observer. This basic somatic sensorimotor resonance plays a critical role in the primitive building block of empathy and moral reasoning that relies on the sharing of others' distress. However, the full-blown capacity of human empathy is more sophisticated than the mere simulation of the target's affective state. Indeed, empathy is about both sharing *and* understanding the emotional state of others in relation to oneself. In this functional magnetic resonance imaging (fMRI) study, 17 typically developing children (range 7–12 yr) were scanned while presented with short animated visual stimuli depicting painful and non-painful situations. These situations involved either a person whose pain was accidentally caused or a person whose pain was intentionally inflicted by another individual. After scanning, children rated how painful these situations appeared. Consistent with previous fMRI studies of pain empathy with adults, the perception of other people in pain in children was associated with increased hemodynamic activity in the neural circuits involved in the processing

of first-hand experience of pain, including the insula, somatosensory cortex, anterior midcingulate cortex, periaqueductal gray, and supplementary motor area. Interestingly, when watching another person inflicting pain onto another, regions that are consistently engaged in representing social interaction and moral behavior (the temporo-parietal junction, the paracingulate, orbital medial frontal cortices, amygdala) were additionally recruited, and increased their connectivity with the fronto-parietal attention network. These results are important to set the standard for future studies with children who exhibit social cognitive disorders (e.g., antisocial personality disorder, conduct disorder) and are often deficient in experiencing empathy or guilt.

- Den Ouden, H. E., Frith, C. D., & Blakemore, S. J. (2005). [Thinking about intentions](#). *Neuroimage*, 28, 787-796.

Abstract

In this fMRI study, we investigated the convergence of underlying neural networks in thinking about a scenario involving one's own intentional action and its consequences and setting up and holding in mind an intention to act. A factorial design was employed comprising two factors: i. Causality (intentional or physical events) and ii. Prospective Memory (present or absent). In each condition, subjects answered questions about various hypothetical scenarios, which related either to the link between the subject's own intentions and consequential actions (Intentional Causality) or to the link between a natural, physical event and its consequences (Physical Causality). A prospective memory task was embedded in half the blocks. In this task, subjects were required to keep in mind an intention (to press a key on seeing a red stimulus background) whilst carrying out the ongoing Causality task. Answering questions about intentional causality versus physical causality activated a network of regions that have traditionally been associated with Theory of Mind, including the medial prefrontal cortex (mPFC), the superior temporal sulcus and the temporal poles bilaterally. In addition, the precuneus bordering with posterior cingulate cortex, an area involved in self-awareness and self-related processing, was activated more when thinking about intentional causality. In the prospective memory task, activations were found in the right parietal cortex, frontopolar cortex (BA 10) and precuneus. Different subregions within the precuneus/posterior cingulate cortex were activated in both main effects of intentional causality and prospective memory. Therefore, the precuneus/posterior cingulate cortex subserves separately thinking about one's own intentions and consequent actions and bearing in mind an intention to make an action. Previous studies have shown that prospective memory, requiring the formation of an intention and the execution of a corresponding action, is associated with decreased activation in the dorsal mPFC, close to the region activated in Theory of Mind tasks. Here, we found that holding in mind an intention to act and at the same time thinking about an intentional action led to reduced activity in a dorsal section of the mPFC. This was a different region from a more anterior, inferior dorsal mPFC region that responded to intentional causality. This suggests that different regions of mPFC play different roles in thinking about intentions.

- Falk, E. B., Rameson, L., Berkman, E. T., Liao, B., Kang, Y., Inagaki, T. K., & Lieberman M. D. (2009). [The neural correlates of persuasion: A common network across cultures and media](#). *Journal of Cognitive Neuroscience*.

Abstract

Persuasion is at the root of countless social exchanges in which one person or group is motivated to have another share its beliefs, desires, or behavioral intentions. Here, we report the first three functional magnetic resonance imaging studies to investigate

the neurocognitive networks associated with feeling persuaded by an argument. In the first two studies, American and Korean participants, respectively, were exposed to a number of text-based persuasive messages. In both Study 1 and Study 2, feeling persuaded was associated with increased activity in posterior superior temporal sulcus bilaterally, temporal pole bilaterally, and dorsomedial prefrontal cortex. The findings suggest a discrete set of underlying mechanisms in the moment that the persuasion process occurs, and are strengthened by the fact that the results replicated across two diverse linguistic and cultural groups. Additionally, a third study using region-of-interest analyses demonstrated that neural activity in this network was also associated with persuasion when a sample of American participants viewed video-based messages. In sum, across three studies, including two different cultural groups and two types of media, persuasion was associated with a consistent network of regions in the brain. Activity in this network has been associated with social cognition and mentalizing and is consistent with models of persuasion that emphasize the importance of social cognitive processing in determining the efficacy of persuasive communication.

- **[Fulltext via länk]** Freeman, J. B., Schiller, D., Rule, N. O., & Ambady, N. (2009). [The neural origins of superficial and individuated judgments about ingroup and outgroup members](#). *Human Brain Mapping*.

Abstract

We often form impressions of others based on superficial information, such as a mere glimpse of their face. Given the opportunity to get to know someone, however, our judgments are allowed to become more individuated. The neural origins of these two types of social judgment remain unknown. We used functional magnetic resonance imaging to dissociate the neural mechanisms underlying superficial and individuated judgments. Given behavioral evidence demonstrating impairments in individuating others outside one's racial group, we additionally examined whether these neural mechanisms are race-selective. Superficial judgments recruited the amygdala. Individuated judgments engaged a cortical network implicated in mentalizing and theory of mind. One component of this mentalizing network showed selectivity to individuated judgments, but exclusively for targets of one's own race. The findings reveal the distinct—and race-selective—neural bases of our everyday superficial and individuated judgments of others.

- **[Fulltext via länk]** Frith, C. D., & Frith, U. (2006). [The neural basis of mentalizing](#). *Neuron*, 50, 531–534.

Abstract

Mentalizing refers to our ability to read the mental states of other agents and engages many neural processes. The brain's mirror system allows us to share the emotions of others. Through perspective taking, we can infer what a person currently believes about the world given their point of view. Finally, the human brain has the unique ability to represent the mental states of the self and the other and the relationship between these mental states, making possible the communication of ideas.

- **[Fulltext via länk]** Gilbert, S. J., Williamson, I. D., Dumontheil, I., Simons, J. S., Frith, C. D., & Burgess, B. W. (2007). [Distinct regions of medial rostral prefrontal cortex supporting social and nonsocial functions](#). *Social Cognitive and Affective Neuroscience*, 2, 217-226.

Abstract

While some recent neuroimaging studies have implicated medial rostral prefrontal cortex (MPFC) in mentalizing and selfreflection, others have implicated this region in attention

towards perceptual vs self-generated information. In order to reconcile these seemingly contradictory findings, we used fMRI to investigate MPFC activity related to these two functions in a factorial design. Participants performed two separate tasks, each of which alternated between stimulus-oriented phases (SO), where participants attended to task-relevant perceptual information, and stimulus-independent phases (SI), where participants performed the same tasks in the absence of such information. In half of the blocks (mentalizing condition), participants were instructed that they were performing these tasks in collaboration with an experimenter; in other blocks (non-mentalizing condition), participants were instructed that the experimenter was not involved. In fact, the tasks were identical in these conditions. Neuroimaging data revealed adjacent but clearly distinct regions of activation within MPFC related to (i) mentalizing vs self-generated information. In order to reconcile these seemingly contradictory findings, we used fMRI to investigate MPFC activity related to these two functions in a factorial design. Participants performed two separate tasks, each of which alternated between stimulus-oriented phases (SO), where participants attended to task-relevant perceptual information, and stimulus-independent phases (SI), where participants performed the same tasks in the absence of such information. In half of the blocks (mentalizing condition), participants were instructed that they were performing these tasks in collaboration with an experimenter; in other blocks (non-mentalizing condition), participants were instructed that the experimenter was not involved. In fact, the tasks were identical in these conditions. Neuroimaging data revealed adjacent but clearly distinct regions of activation within MPFC related to (i) mentalizing vs non-mentalizing conditions (relatively caudal/superior) and (ii) SO vs SI attention (relatively rostral/inferior). These results generalized from one task to the other, suggesting a new axis of functional organization within MPFC.

- **NY!** Gobbini, M. I., Gentili, C., Ricciardi, E., Bellucci, C., Salvini, P., Laschi, C., Guazzelli, M., & Pietrini, P. (2010). [Distinct Neural Systems Involved in Agency and Animacy Detection](#). *Journal of Cognitive Neuroscience*. Tidig elektronisk publicering.

Abstract

We designed an fMRI experiment comparing perception of human faces and robotic faces producing emotional expressions. The purpose of our experiment was to investigate engagement of different parts of the social brain by viewing these animate and inanimate agents. Both human and robotic face expressions evoked activity in face-responsive regions in the fusiform gyrus and STS and in the putative human mirror neuron system. These results suggest that these areas mediate perception of agency, independently of whether the agents are living or not. By contrast, the human faces evoked stronger activity than did robotic faces in the medial pFC and the anterior temporal cortex—areas associated with the representation of others' mental states (theory of mind), whereas robotic faces evoked stronger activity in areas associated with perception of objects and mechanical movements. Our data demonstrate that the representation of the distinction between animate and inanimate agents involves areas that participate in attribution of mental stance.

- Güroglu, B., van den Bos, W., Rombouts, S. A., & Crone, E. A. (2010). [Unfair? It depends: Neural correlates of fairness in social context](#). *Social Cognitive and Affective Neuroscience*.

Abstract

Fairness is a key concept in social interactions and is influenced by intentionality considerations. In this functional magnetic resonance imaging study, we investigated the neural correlates of fairness by focusing on responder behavior to unfair offers in an Ultimatum Game paradigm with conditions that differed in their intentionality

constraints. Brain activity underlying rejection vs acceptance of unfair offers appeared highly dependent on intentionality. Rejection of unfair offers when the proposer had no alternative as well as acceptance of offers when the proposer had a fair- or hyperfair-alternative was associated with activation in a network of regions including the insula and the dorsal medial prefrontal cortex. These activations were interpreted as neural responses to norm violations because they were mostly involved when behavior was inconsistent with socially accepted behavior patterns. Rejection of unfair offers in the no-alternative condition further resulted in activity in the anterior medial prefrontal cortex and the temporoparietal junction, which was interpreted in terms of higher moral mentalizing demands required in social decision-making when rejection could not be readily justified. Together, results highlight the significance of intentionality considerations in fairness-related social decision-making processes.

- Halko, M. L., Hlushchuk, Y., Hari, R., & Schürmann, M. (2009). [Competing with peers: Mentalizing-related brain activity reflects what is at stake](#). *Neuroimage*, 46, 542-548.

Abstract

Competition imposes constraints for humans who make decisions. Concomitantly, people do not only maximize their personal profit but they also try to punish unfair conspecifics. In bargaining games, subjects typically accept equal-share offers but reject unduly small offers; competition affects this balance. Here we used functional magnetic resonance imaging (fMRI) to study adjustment to competition in a bargaining game where subjects competed against another person for a share of the stake. For medium-sized, but not for minimum offers, competition increased the likelihood of acceptance and thus shifted behavior towards maximizing personal profits, emphasizing the importance of financial incentives. Specifically for medium-sized offers, competition was associated with increased brain activation bilaterally in the temporo-parietal junction, a region associated with mentalizing. In the right inferior frontal region, competition-related brain activation was strongest in subjects whose high acceptance rates in the standard ultimatum game hinted at a profit-oriented approach. The results suggest a network of brain areas supporting decision making under competition, with incentive-dependent mentalizing engaged when the competitor's behavior is difficult to predict and when the stake is attractive enough to justify the effort.

- [\[Fulltext via länk\]](#) Hooker, C. I., Verosky, S. C., Germine, L. T., Knight, R. T., & D'Esposito, M. (2008). [Mentalizing about emotion and its relationship to empathy](#). *Social Cognitive and Affective Neuroscience*, 3, 204-217.

Abstract

Mentalizing involves the ability to predict someone else's behavior based on their belief state. More advanced mentalizing skills involve integrating knowledge about beliefs with knowledge about the emotional impact of those beliefs. Recent research indicates that advanced mentalizing skills may be related to the capacity to empathize with others. However, it is not clear what aspect of mentalizing is most related to empathy. In this study, we used a novel, advanced mentalizing task to identify neural mechanisms involved in predicting a future emotional response based on a belief state. Subjects viewed social scenes in which one character had a False Belief and one character had a True Belief. In the primary condition, subjects were asked to predict what emotion the False Belief Character would feel if they had a full understanding about the situation. We found that neural regions related to both mentalizing and emotion were involved when predicting a future emotional response, including the superior temporal sulcus, medial prefrontal cortex, temporal poles, somatosensory related cortices (SRC), inferior

frontal gyrus and thalamus. In addition, greater neural activity in primarily emotion-related regions, including right SRC and bilateral thalamus, when predicting emotional response was significantly correlated with more self-reported empathy. The findings suggest that predicting emotional response involves generating and using internal affective representations and that greater use of these affective representations when trying to understand the emotional experience of others is related to more empathy.

- Hooker, C. I., Verosky, S. C., Germine, L. T., Knight, R. T., & D'Esposito, M. (2009). [Neural activity during social signal perception correlates with self-reported empathy](#). *Brain Research*.

Abstract

Empathy is an important component of human relationships, yet the neural mechanisms that facilitate empathy are unclear. The broad construct of empathy incorporates both cognitive and affective components. Cognitive empathy includes mentalizing skills such as perspective-taking. Affective empathy consists of the affect produced in response to someone else's emotional state, a process which is facilitated by simulation or "mirroring." Prior evidence shows that mentalizing tasks engage a neural network which includes the temporoparietal junction, superior temporal sulcus, and medial prefrontal cortex. On the other hand, simulation tasks engage the fronto-parietal mirror neuron system (MNS) which includes the inferior frontal gyrus (IFG) and the somatosensory related cortex (SRC). Here, we tested whether neural activity in these two neural networks was related to self-reports of cognitive and affective empathy in daily life. Participants viewed social scenes in which the shift of direction of attention of a character did or did not change the character's mental and emotional state. As expected, the task robustly activated both mentalizing and MNS networks. We found that when detecting the character's change in mental and emotional state, neural activity in both networks is strongly related to cognitive empathy. Specifically, neural activity in the IFG, SRC, and STS were related to cognitive empathy. Activity in the precentral gyrus was related to affective empathy. The findings suggest that both simulation and mentalizing networks contribute to multiple components of empathy.

- Hughes, C., Jaffee, S. R., Happé, F., Taylor, Caspi, A., & Moffitt, T. E. (2005). [Origins of individual differences in theory of mind: From nature to nurture?](#) *Child Development*, 76, 356-370.

Abstract

In this study of the origins of individual differences in theory of mind (ToM), the Environmental Risk (E-Risk) Longitudinal Twin Study sample of 1,116 sixty-month-old twin pairs completed a comprehensive battery of ToM tasks. Individual differences in ToM were striking and strongly associated with verbal ability. Behavioral genetic models of the data showed that environmental factors explained the majority of the variance in ToM performance in this sample. Shared environmental influences on verbal ability had a common impact on ToM and explained more than half the phenotypic correlation between these two skills. Possible underlying proximal mechanisms are discussed, including maternal speech and mind-mindedness, sibling interactions, and peer influences.

- Jenkins, A. C., & Mitchell, J. P. (2009). [Mentalizing under uncertainty: Dissociated neural responses to ambiguous and unambiguous mental state inferences](#). *Cerebral Cortex*.

Abstract

The ability to read the minds of others (i.e., to mentalize) requires that perceivers understand a wide range of different kinds of mental states, including not only others'

beliefs and knowledge but also their feelings, desires, and preferences. Moreover, although such inferences may occasionally rely on observable features of a situation, perceivers more typically mentalize under conditions of “uncertainty,” in which they must generate plausible hypotheses about a target's mental state from ambiguous or otherwise underspecified information. Here, we use functional neuroimaging to dissociate the neural bases of these 2 distinct social–cognitive challenges: 1) mentalizing about different types of mental states (beliefs vs. preferences) and 2) mentalizing under conditions of varying ambiguity. Although these 2 aspects of mentalizing have typically been confounded in earlier research, we observed a double dissociation between the brain regions sensitive to type of mental state and ambiguity. Whereas ventral and dorsal aspects of medial prefrontal cortex responded more during ambiguous than unambiguous inferences regardless of the type of mental state, the right temporoparietal junction was sensitive to the distinction between beliefs and preferences irrespective of certainty. These results underscore the emerging consensus that, rather than comprising a single mental operation, social cognition makes flexible use of different processes as a function of the particular demands of the social context.

- Johnson, M. H., Grossman, T., & Kadosh, K. C. (2009). [Mapping functional brain development: Building a social brain through interactive specialization](#). *Developmental Psychology*, 45, 151-159.

Abstract

The authors review a viewpoint on human functional brain development, interactive specialization (IS), and its application to the emerging network of cortical regions referred to as the *social brain*. They advance the IS view in 2 new ways. First, they extend IS into a domain to which it has not previously been applied—the emergence of social cognition and mentalizing computations in the brain. Second, they extend the implications of the IS view from the emergence of specialized functions within a cortical region to a focus on how different cortical regions with complementary functions become orchestrated into networks during human postnatal development.

- **[Fulltext via länk]** Krach, S., Bluemel, I., Marjoram, D., Lataster, T., Krabbendam, L., Weber, J., et al. (2009). [Are women better mindreaders? Sex differences in neural correlates of mentalizing detected with functional MRI](#). *BMC Neuroscience*, 10.

Abstract

Background: The ability to mentalize, i.e. develop a Theory of Mind (ToM), enables us to anticipate and build a model of the thoughts, emotions and intentions of others. It has long been hypothesised that women differ from men in their mentalizing abilities. In the present fMRI study we examined the impact of (1) gender (women vs. men) and (2) game partner (human vs. computer) on ToM associated neural activity in the medial prefrontal cortex. Groups of men (n = 12) and women (n = 12) interacted in an iterated classical prisoner's dilemma forced choice situation with alleged human and computer partners who were outside the scanner.

Results: Both the conditions of playing against putative human as well as computer partners led to activity increases in mPFC, ACC and rTPJ, constituting the classic ToM network. However, mPFC/ACC activity was more pronounced when participants believed they were playing against the alleged human partner. Differences in the medial frontal lobe activation related to the sex of the participants could be demonstrated for the human partner > computer partner contrast.

Conclusion: Our data demonstrate differences in medial prefrontal brain activation during a ToM task depending on both the gender of participants and the game partner.

- Kuzmanovic, B., Georgescu, A., Eickhoff, S., Shah, N. J., Gente, G., Fink, G. R., & Vogeley, K. (2009). [Duration matters: Dissociating neural correlates of detection and evaluation of social gaze](#). *NeuroImage*, 46, 1154-1163.

Abstract

The interpretation of interpersonal gaze behavior requires the use of complex cognitive processes and guides social interactions. Among a variety of different gaze characteristics, gaze direction and gaze duration modulate crucially the meaning of the "social gaze". Nevertheless, prior neuroimaging studies disregarded the relevance of gaze duration by focusing on gaze direction only.

The present functional magnetic resonance imaging (fMRI) study focused on the differentiation of these two gaze parameters. Therefore direct gaze displayed by virtual characters was contrasted with averted gaze and, additionally, systematically varied with respect to gaze duration (i.e., 1, 2.5 or 4 s). Consistent with prior findings, behavioral data showed that likeability was higher for direct than for averted gaze and increased linearly with increasing direct gaze duration. On the neural level, distinct brain regions were associated with the processing of gaze direction and gaze duration: (i) the comparison between direct and averted gaze revealed activations in bilateral occipito-temporal regions including the posterior superior temporal sulcus (pSTS); (ii) whereas increasing duration of direct gaze evoked differential neural responses in the medial prefrontal cortex (MPFC) including orbitofrontal and paracingulate regions.

The results suggest two complementary cognitive processes related to different gaze parameters. On the one hand, the recruitment of multimodal sensory regions in the pSTS indicates *detection* of *gaze direction* via complex visual analysis. On the other hand, the involvement of the MPFC associated with outcome monitoring and mentalizing indicates higher-order social cognitive processes related to *evaluation* of the ongoing communicational input conveyed by *direct gaze duration*.

- Lackner, C. L., Bowman, L. C., & Sabbagh, M. A. (2010). [Dopaminergic functioning and preschoolers' theory of mind](#). *Neuropsychologica*.

Abstract

Representational theory of mind (RTM) development follows a universal developmental timetable whereby major advances in reasoning about mental representations occur between the ages of 3 and 5 years old. This progression appears to be only absent in the case of specific neurodevelopmental impairments, such as autism. Taken together, this suggests that neuromaturational factors may play a role in RTM development. Recent EEG work has shown that one neuromaturational factor pacing this universal developmental timetable is the functional maturation of medial prefrontal cortex. The neurotransmitter dopamine (DA) is thought to play a crucial role in typical frontal lobe development. Therefore, the goal of the present study was to investigate the role that DA may play in RTM development. Ninety-one 48–62-month olds were given a battery of RTM tasks along with EEG measurement. EEG recordings were analyzed for eyeblinks, a reliable indicator of DA functioning, and we calculated their average eyeblinks per minute (EBR). Regression analyses showed that EBR was associated with RTM after controlling for children's performance on a Stroop-like measure, language ability, gender, and age. These findings provide evidence that DA functioning is associated with RTM in the preschool years, and are discussed with respect to how DA might provide a mechanism that helps to account for both neurobiological and experiential factors that are known to affect the timetable of preschoolers' RTM development.

- **NY!** Liew, S. L., Han, S., & Aziz-Zadeh, L. (2010). [Familiarity modulates mirror neuron and mentalizing regions during intention understanding](#). *Human Brain Mapping*. Tidig elektronisk publicering.

Abstract

Recent research suggests that the inference of others' intentions from their observed actions is supported by two neural systems that perform complementary roles. The human putative mirror neuron system (pMNS) is thought to support automatic motor simulations of observed actions, with increased activity for previously experienced actions, whereas the mentalizing system provides reflective, non-intuitive reasoning of others' perspectives, particularly in the absence of prior experience. In the current fMRI study, we show how motor familiarity with an action and perceptual familiarity with the race of an actor uniquely modulate these two systems. Chinese participants were asked to infer the intentions of actors performing symbolic gestures, an important form of non-verbal communication that has been shown to activate both mentalizing and mirror neuron regions. Stimuli were manipulated along two dimensions: (1) actor's race (Caucasian vs. Chinese actors) and (2) participants' level of experience with the gestures (familiar or unfamiliar). We found that observing all gestures compared to observing still images was associated with increased activity in key regions of both the pMNS and mentalizing systems. In addition, observations of one's same race generated greater activity in the posterior pMNS-related regions and the insula than observations of a different race. Surprisingly, however, familiar gestures more strongly activated regions associated with mentalizing, while unfamiliar gestures more strongly activated the posterior region of the pMNS, a finding that is contrary to prior literature and demonstrates the powerful modulatory effects of both motor and perceptual familiarity on pMNS and mentalizing regions when asked to infer the intentions of intransitive gestures.

- Liu, D., Meltzoff, A. N., & Wellman, H. M. (2009). [Neural correlates of beliefs- and desire-reasoning](#). *Child Development*, 80, 1163-1171.

Abstract

Theory of mind requires an understanding of both desires and beliefs. Moreover, children understand desires before beliefs. Little is known about the mechanisms underlying this developmental lag. Additionally, previous neuroimaging and neurophysiological studies have neglected the direct comparison of these developmentally critical mental-state concepts. Event-related brain potentials were recorded as participants ($N = 24$; mean age = 22 years) reasoned about diverse-desires, diverse-beliefs, and parallel physical situations. A mid-frontal late slow wave (LSW) was associated with desire and belief judgments. A right-posterior LSW was only associated with belief judgments. These findings demonstrate neural overlap and critical differences in reasoning explicitly about desires and beliefs, and they suggest children recruit additional neural processes for belief judgments beyond a common, more general, mentalizing neural system.

- Lombardo, M. V., Chakrabarti, B., & Baron-Cohen, S. (2009). [What neuroimaging and perceptions of self-other similarity can tell us about the mechanism underlying mentalizing](#). *Behavioral and Brain Sciences*, 32, 152-153.

Abstract

Carruthers' "mindreading is prior" model postulates one unitary mindreading mechanism working identically for self and other. While we agree about shared mindreading mechanisms, there is also evidence from neuroimaging and mentalizing about dissimilar others that suggest factors that differentially affect self-versus-other mentalizing. Such

dissociations suggest greater complexity than the mindreading is prior model allows.

- Lombardo, M. V., Chakrabarti, B., Bullmore, E. T., Wheelwright, S. J., Sadek, S. A., Pasco, G. , et al. (2009). [Shared neural circuits for mentalizing about the self and others](#). *Journal of Cognitive Neuroscience*.

Abstract

Although many examples exist for shared neural representations of self and other, it is unknown how such shared representations interact with the rest of the brain. Furthermore, do high-level inference-based shared mentalizing representations interact with lower level embodied/simulation-based shared representations? We used functional neuroimaging (fMRI) and a functional connectivity approach to assess these questions during high-level inference-based mentalizing. Shared mentalizing representations in ventromedial prefrontal cortex, posterior cingulate/precuneus, and temporo-parietal junction (TPJ) all exhibited identical functional connectivity patterns during mentalizing of both self and other. Connectivity patterns were distributed across low-level embodied neural systems such as the frontal operculum/ventral premotor cortex, the anterior insula, the primary sensorimotor cortex, and the presupplementary motor area. These results demonstrate that identical neural circuits are implementing processes involved in mentalizing of both self and other and that the nature of such processes may be the integration of low-level embodied processes within higher level inference-based mentalizing.

- **NY!** Ma, N., Vandekerckhove, M., Van Overwalle, F., Seurinck, R., & Fias, W. (2010). [Spontaneous and intentional trait inferences recruit a common mentalizing network to a different degree: Spontaneous inferences activate only its core areas](#). *Social Neuroscience*. Tidig elektronisk publicering.

Abstract

This fMRI study analyzes inferences on other persons' traits, whereby half of the participants were given spontaneous ("read") instructions while the other half were given intentional ("infer the person's trait") instructions. Several sentences described the behavior of a target person from which a strong trait could be inferred (trait diagnostic) or not (trait nondiagnostic). A direct contrast between spontaneous and intentional instructions revealed no significant differences, indicating that the same social mentalizing network was recruited. There was, however, a difference with respect to different brain areas that passed the significance threshold, suggesting that this common network was recruited to a different degree. Specifically, spontaneous inferences significantly recruited only core mentalizing areas, including the temporo-parietal junction and medial prefrontal cortex, whereas intentional inferences additionally recruited other brain areas, including the (pre)cuneus, superior temporal sulcus, temporal poles, and parts of the premotor and parietal cortex. These results suggest that intentional instructions invite observers to think more about the material they read, and consider it in many ways besides its social impact. Future research on the neurological underpinnings of trait inference might profit from the use of spontaneous instructions to get purer results that involve only the core brain areas in social judgment.

- Mano, Y., Harada, T., Sugiura, M., Saito, D. N., & Sadato, N. (2009). [Perspective-taking as part of narrative comprehension: A functional MRI study](#). *Neuropsychologia*, 47, 813-824.

Abstract

During narrative comprehension, readers understand the emotions of the protagonist

by taking the perspective of the character, which is an essential component of empathy. Spatial perspective-taking is crucial to understanding the standpoints and perceptions of others, and gives clues as to what the protagonist knows. As a default, a “here and now” point-of-view is adopted to make sense of the narrative. If the protagonist is in a different location while an event takes place (“there and now”), in order to comprehend the narrative the reader must take an allocentric perspective, which places greater demands on spatial perspective-taking. Utilizing this phenomenon, we evaluated the neural substrates of perspective-taking in emotional narrative comprehension using functional MRI in 18 normal adults. The subjects read short stories followed by a target sentence, which described an event that might evoke an emotional response in the protagonist if the character were present. The stories involved a scenario in which the character was either present at the same location (“here and now”) or at a distant location (“there and now”) during the event. The “there and now” scenario activated the posterior cingulate cortex and the right temporo-parietal junction more prominently than the “here and now” condition. In contrast to the control tasks, both scenarios activated the well-known mentalizing network including the dorsomedial prefrontal cortex, temporal pole, posterior cingulate cortex and temporo-parietal junction. Along with the mentalizing network, the posterior cingulate cortex and the right temporo-parietal junction are involved in spatial perspective-taking during emotional narrative comprehension.

- **NY!** Masten, C. L., Eisenberger, N. I., Pfeifer, J. H., & Dapretto, M. (2010). [Witnessing peer rejection during early adolescence: Neural correlates of empathy for experiences of social exclusion](#). *Social Neuroscience*, 5, 496-507.

Abstract

Neuroimaging studies with adults have begun to reveal the neural bases of empathy; however, this research has focused on empathy for physical pain, rather than empathy for negative social experiences. Moreover, this work has not examined adolescents who may frequently witness and empathize with others that experience negative social experiences such as peer rejection. Here, we examined neural activity among early adolescents observing social exclusion compared to observing inclusion, and how this activity related to both trait empathy and subsequent prosocial behavior. Participants were scanned while they observed an individual whom they believed was being socially excluded. At least one day prior to the scan they reported their trait empathy, and following the scan they wrote emails to the excluded victim that were rated for prosocial behavior (e.g., helping, comforting). Observing exclusion compared to inclusion activated regions involved in mentalizing (i.e., dorsomedial prefrontal cortex), particularly among highly empathic individuals. Additionally, individuals who displayed more activity in affective, pain-related regions during observed exclusion compared to inclusion subsequently wrote more prosocial emails to excluded victims. Overall findings suggest that when early adolescents witness social exclusion in their daily lives, some may actually 'feel the pain' of the victims and act more prosocially toward them as a result.

- Ohnishi, T., Moriguchi, Y., Matsuda, H., Takeyuki, M., Hirakata, M., Ibayashi, E. et al. (2004). [The neural network for the mirror system and mentalizing in normally developed children: An fMRI study](#). *Neuroreport*, 15, 1483-1487.

Abstract

We performed fMRI measurements in normal children to clarify which cortical areas are commonly involved in the mirror system (MS) and mentalizing, which areas are specific for mentalizing, and whether children have the same neural networks for MS and mentalizing as adults. Normal children had the same neural networks for the MS and

mentalizing as adults. Common activations were found in the superior temporal sulcus and the fusiform gyri, whereas mentalizing specific activation was found in the medial prefrontal, temporal pole and the inferior parietal cortices. We suggest that mentalizing might evolve from a capacity to detect the motion of agents and to infer intentions. Further, mentalizing might require self-perspectives.

- Overwalle, F. Van., & Baetens, K. (2009). [Understanding others' actions and goals by mirror and mentalizing systems: A meta-analysis](#). *NeuroImage*.

Abstract

This meta-analysis explores the role of the mirror and mentalizing systems in the understanding of other people's action goals. Based on over 200 fMRI studies, this analysis demonstrates that the mirror system – consisting of the *anterior intraparietal sulcus* and the *premotor cortex* – is engaged when one perceives articulated motions of body parts irrespective of their sensory (visual or auditory) or verbal format as well as when the perceiver executes them. This confirms the matching role of the mirror system in understanding biological action. Observation of whole-body motions and gaze engage the *posterior superior temporal sulcus* and most likely reflects an orientation response in line with the action or attention of the observed actor. In contrast, the mentalizing system – consisting of the *temporo-parietal junction*, the *medial prefrontal cortex* and the *precuneus* – is activated when behavior that enables inferences to be made about goals, beliefs or moral issues is presented in abstract terms (e.g., verbal stories or geometric shapes) and there is no perceivable biological motion of body parts. A striking overlap of brain activity at the temporo-parietal junction between social inferences and other, non-social observations (e.g., Posner's cuing task) suggests that this area computes the orientation or direction of the behavior in order to predict its likely end-state (or goal). No conclusions are drawn about the specific functionality of the precuneus and the medial prefrontal cortex. Because the mirror and mentalizing systems are rarely concurrently active, it appears that neither system subserves the other. Rather, they are complementary. There seems, however, to be a transition from the mirror to the mentalizing system even when body-part motions are observed by perceivers who are consciously deliberating about the goals of others and their behavioral executions, such as when perceived body motions are contextually inconsistent, implausible or pretended.

- **NY!** Pellen, M. V., Atkinson, A. P., & Vuilleumier, P. (2010). [Supramodal Representations of Perceived Emotions in the Human Brain](#). *Journal of Neuroscience*, 30, 10127-10134.

Abstract

Basic emotional states (such as anger, fear, and joy) can be similarly conveyed by the face, the body, and the voice. Are there human brain regions that represent these emotional mental states regardless of the sensory cues from which they are perceived? To address this question, in the present study participants evaluated the intensity of emotions perceived from face movements, body movements, or vocal intonations, while their brain activity was measured with functional magnetic resonance imaging (fMRI). Using multivoxel pattern analysis, we compared the similarity of response patterns across modalities to test for brain regions in which emotion-specific patterns in one modality (e.g., faces) could predict emotion-specific patterns in another modality (e.g., bodies). A whole-brain searchlight analysis revealed modality-independent but emotion category-specific activity patterns in medial prefrontal cortex (MPFC) and left superior temporal sulcus (STS). Multivoxel patterns in these regions contained information about the category of the perceived emotions (anger, disgust, fear, happiness, sadness) across all modality comparisons (face–body, face–voice, body–voice), and independently of

the perceived intensity of the emotions. No systematic emotion-related differences were observed in the overall amplitude of activation in MPFC or STS. These results reveal supramodal representations of emotions in high-level brain areas previously implicated in affective processing, mental state attribution, and theory-of-mind. We suggest that MPFC and STS represent perceived emotions at an abstract, modality-independent level, and thus play a key role in the understanding and categorization of others' emotional mental states.

- **NY!** Perry, D., Hendler, T., & Shamay-Tsoory, S. G. (2010). [Projecting memories: The role of the hippocampus in emotional mentalizing](#). *NeuroImage*. Tidig elektronisk publicering.

Abstract

Humans have a striking tendency to use past autobiographical events to understand their own behavior. However, it is unknown if we use our own memories to understand others. To assess the role of autobiographical memory in mentalizing we examined the contribution of memory structures, specifically the hippocampus, to emotional judgment of others. Subjects were scanned while making emotional judgments regarding themselves, and protagonists deemed similar to or dissimilar from themselves. Results indicated a significant correlation between rating of the self and the similar protagonists, particularly for the events subjects recalled from their past. Furthermore, we found an interaction between similarity and recollection so that only for events subjects recalled from their past, the hippocampus reacted differently for judgments regarding the self versus dissimilar others, but not for self versus similar others. These results suggest that people actually use their own repertoire of memories and project internal self knowledge while making emotional judgments regarding others. It is speculated that mentalizing is modulated by memories of similar past events and depends on the protagonist we face.

- **NY!** Powell, J. L., Lewis, P. A., Dunbar, R. I., García-Fiñana, M., & Roberts, N. (2010). [Orbital prefrontal cortex volume correlates with social cognitive competence](#). *Neuropsychologica*, 48, 3554-3562.

Abstract

Intentionality, or Theory of Mind, is the ability to explain and predict the behaviour of others by attributing to them intentions and mental states and is hypothesised to be one of several social cognitive mechanisms which have impacted upon brain size evolution. Though the brain activity associated with processing this type of information has been studied extensively, the neuroanatomical correlates of these abilities, e.g. whether subjects who perform better have greater volume of associated brain regions, remain to be investigated. Because social abilities of this type appear to have evolved relatively recently, and because the prefrontal cortex (PFC) was the last brain region to develop both phylogenetically and ontogenetically, we hypothesised a relationship between PFC volume and intentional competence. To test this, we estimated the volume of four regional prefrontal subfields in each cerebral hemisphere, in 40 healthy adult humans by applying stereological methods on T1-weighted magnetic resonance images. Our results reveal a significant linear relationship between intentionality score and volume of orbital PFC ($p = 0.01$). Since this region is known to be involved in the processing of social information our findings support the hypothesis that brain size evolution is, at least in part, the result of social cognitive mechanisms supporting social cohesion.

- **[Fulltext via länk]** Schippers, M. B., Gazzola, V., Goebel, R., & Keysers, C. (2009). [Playing charades in the fMRI: Are mirror and/or mentalizing areas involved in gestural communication?](#) *PLoS ONE*, 4, e6801.

Abstract

Communication is an important aspect of human life, allowing us to powerfully coordinate our behaviour with that of others. Boiled down to its mere essentials, communication entails transferring a mental content from one brain to another. Spoken language obviously plays an important role in communication between human individuals. Manual gestures however often aid the semantic interpretation of the spoken message, and gestures may have played a central role in the earlier evolution of communication. Here we used the social game of charades to investigate the neural basis of gestural communication by having participants produce and interpret meaningful gestures while their brain activity was measured using functional magnetic resonance imaging. While participants decoded observed gestures, the putative mirror neuron system (pMNS: premotor, parietal and posterior mid-temporal cortex), associated with motor simulation, and the temporo-parietal junction (TPJ), associated with mentalizing and agency attribution, were significantly recruited. Of these areas only the pMNS was recruited during the production of gestures. This suggests that gestural communication relies on a combination of simulation and, during decoding, mentalizing/agency attribution brain areas. Comparing the decoding of gestures with a condition in which participants viewed the same gestures with an instruction not to interpret the gestures showed that although parts of the pMNS responded more strongly during active decoding, most of the pMNS and the TPJ did not show such significant task effects. This suggests that the mere observation of gestures recruits most of the system involved in voluntary interpretation.

- **NY!** Schnell, K., Bluschke, S., Konradt, B., & Walter, H. (2010). [Functional relations of empathy and mentalizing: An fMRI study on the neural basis of cognitive empathy](#). *NeuroImage*. Tidig elektronisk publicering.

Abstract

This fMRI study was set up to explore how cognitive empathy, i.e. the cognitive inference on another person's affective state, can be characterized as a distinct brain function relating to pre-existing neurofunctional concepts about mentalizing and empathy. In a 3 Tesla MRI scanner 28 healthy participants were presented with four different instructions randomly combined with 32 false-belief cartoon stories of 3 subsequent pictures free of direct cues for affective states, like e.g. facial expressions. Participants were instructed to judge affective or visuospatial changes from their own (1st person perspective) or the protagonists' (3rd person perspective, 3rdpp) perspective. 3rdpp-judgements about affective states differed from visuospatial 3rdpp judgements by a significantly higher activation of the anterior mentalizing network (dorsomedial prefrontal cortex, anterior superior temporal sulcus, temporal poles) and the limbic system (left amygdala and hippocampus). Analysis of main effects revealed that the anterior part of the mentalizing network was activated significantly stronger by affective compared to visuospatial content. In contrast, the temporoparietal junction was rather activated by 3rdpp visuospatial judgements. After all, our results demonstrate a functional dissociation between cognitive empathy and cognitive visuospatial perspective taking. The simultaneous activation of the cortical mentalizing network and the amygdala indicates that cognitive empathy actually involves reference to own affective states in the observer. Notably, the cognitive reference to own affective states activated the mentalizing network as well. Moreover our results support pre-existing ideas about a functional anterior-posterior subdivision of the mentalizing network, depending on affective content and 3rd person perspective of cognition.

- Shibata, M., Toyomura, A., Itoh, H., & Abe, J. I. (2009). [Neural substrates of irony](#)

[comprehension: A functional MRI study](#). *Brain Research*.

Abstract

In daily communication, we sometimes use ironic expressions to convey the opposite meaning. To understand these contradictory statements, we have to infer contextual implications and the speaker's mental state. However, little is known about how our brains carry out these complex processes. In this study, we investigated the neural substrates involved in irony comprehension using echoic utterance (Sperber and Wilson, 1986, 1995). Participants read a short scenario that consisted of five sentences. The first four sentences explained the situation of the protagonists. The fifth connoted either an ironic, literal, or unconnected meaning. The participants had to press a button to indicate whether or not the final sentence expressed irony. In the ironic sentence condition, the bilateral superior frontal gyrus, middle frontal gyrus, inferior frontal gyrus, medial prefrontal cortex, superior temporal gyrus, inferior parietal lobule, caudate, thalamus, the left insula, and amygdala were activated. In the literal sentence condition, the right superior frontal gyrus, the bilateral middle frontal gyrus, inferior frontal gyrus, medial prefrontal cortex, superior temporal gyrus, inferior parietal lobule, caudate, the left insula, the right thalamus, and the left amygdala were activated. However, in the ironic sentence condition minus the literal sentence condition, we observed higher activation in the right medial prefrontal cortex (BA 10), the right precentral (BA 6), and the left superior temporal sulcus (BA 21). Our results suggest that irony comprehension is strongly related to mentalizing processes and that activation in these regions might be affected by higher-order cognitive operations.

- **NY!** Sommer, M., Meinhardt, J., Eichenmüller, K., Sodian, B., Döhnell, K., & Hajak, G. (2010). [Modulation of the cortical false belief network during development](#). *Brain Research*, 1354, 123-131.

Abstract

The ability to represent false beliefs is commonly considered as to be the critical test for having a Theory of Mind (ToM). For correct predictions or explanations of other peoples' behavior it is necessary to understand that mental states are sometimes independent of reality and misrepresent the real state of the world. In contrast, when people hold true beliefs, predictions and explanations about behavior can simply be derived from reality. Previous neuroimaging studies with adults suggest that the dorsal medial prefrontal cortex (dmPFC) and the right temporo-parietal junction (rTPJ) are engaged in false belief reasoning. However, studies investigating the neural correlates of belief reasoning in children are rare. Using cartoon stories that depicted an unexpected transfer, we compared false belief reasoning with true belief reasoning in children of a narrow age range between 10 and 12 years and in adults. In both groups, the dorsal medial frontal cortex was activated during false versus true belief reasoning. In contrast to adults, children did not selectively recruit the rTPJ during false belief reasoning. We found a group by belief interaction in the right rostral PFC and the posterior cingulate cortex. In these areas, children compared to adults showed increased activity associated with false belief reasoning in contrast to true belief reasoning. These results implicate modulation of the cortical network that underlies false belief reasoning during development and far beyond the time children successfully master false belief tasks.

- Spengler, S., von Cramon, D. Y., & Bass, M. (2009). [Control of shared representations relies on key processes involved in mental state attribution](#). *Human Brain Mapping*.

Abstract

Action observation leads to the automatic activation of the corresponding motor representation in the observer through “mirror-matching.” This constitutes a “shared representational system,” which is thought to subserve social understanding by motor simulation. However, it is unclear how these shared representations can be controlled and distinguished. Brain imaging suggests that controlling shared representations, indexed by the ability to control automatic imitative responses, activates anterior fronto-medial cortex (aFMC), and temporo-parietal junction (TPJ). Crucially, these regions are also consistently implicated in mental state attribution and have provided an alternative account for higher-level social cognition. Here, we directly tested whether social-cognitive processes involve similar key computational mechanisms as the control of shared representations by using functional brain imaging to reveal overlapping brain circuits. We show in a within-subject design that commonly activated regions occurred selectively in aFMC and TPJ. Mentalizing and self-referential thoughts recruited a region in aFMC, which was also activated when controlling imitation. In the TPJ, an area overlapped between mentalizing, agency processing, and imitative control. Behavioral and neural correlates of mentalizing were further related to the individual ability for controlling imitation. Our findings support the assumption of shared key processes and suggest a novel link between embodied and social cognition.

- Spunt, R. P., Satpute, A. B., & Lieberman, M. D. (2010). [Identifying the what, why, and how of an observed action: An fMRI study of mentalizing and mechanizing during action observation.](#) *Journal of Cognitive Neuroscience.*

Abstract

Humans commonly understand the unobservable mental states of others by observing their actions. Embodied simulation theories suggest that this ability may be based in areas of the fronto-parietal mirror neuron system, yet neuroimaging studies that explicitly investigate the human ability to draw mental state inferences point to the involvement of a “mentalizing” system consisting of regions that do not overlap with the mirror neuron system. For the present study, we developed a novel action identification paradigm that allowed us to explicitly investigate the neural bases of mentalizing observed actions. Across repeated viewings of a set of ecologically valid video clips of ordinary human actions, we manipulated the extent to which participants identified the unobservable mental states of the actor (*mentalizing*) or the observable mechanics of their behavior (*mechanizing*). Although areas of the mirror neuron system did show an enhanced response during action identification, its activity was not significantly modulated by the extent to which the observers identified mental states. Instead, several regions of the mentalizing system, including dorsal and ventral aspects of medial pFC, posterior cingulate cortex, and temporal poles, were associated with mentalizing actions, whereas a single region in left lateral occipito-temporal cortex was associated with mechanizing actions. These data suggest that embodied simulation is insufficient to account for the sophisticated mentalizing that human beings are capable of while observing another and that a different system along the cortical midline and in anterior temporal cortex is involved in mentalizing an observed action.

- Straube, B., Green, A., Jansen, A., Chatterjee, A., & Kircher, T. (2009). [Social cues, mentalizing and the neural processing of speech accompanied by gestures.](#) *Neuropsychologica.*

Abstract

Body orientation and eye gaze influence how information is conveyed during face-to-face communication. However, the neural pathways underpinning the comprehension of social cues in everyday interaction are not known. In this study we investigated the influence

of addressing vs. non-addressing body orientation on the neural processing of speech accompanied by gestures.

While in an fMRI scanner, participants viewed short video clips of an actor speaking sentences with object- (O; e.g., shape) or person-related content (P; e.g., saying goodbye) accompanied by iconic (e.g., circle) or emblematic gestures (e.g., waving), respectively. The actor's body was oriented either toward the participant (frontal, F) or toward a third person (lateral, L) not visible.

For frontal vs. lateral actor orientation ($F > L$), we observed activation of bilateral occipital, inferior frontal, medial frontal, right anterior temporal and left parietal brain regions. Additionally, we observed activity in the occipital and anterior temporal lobes due to an interaction effect between actor orientation and content of the communication ($PF > PL > (OF > OL)$).

Our findings indicate that social cues influence the neural processing of speech–gesture utterances. Mentalizing (the process of inferring the mental state of another individual) could be responsible for these effects. In particular, socially relevant cues seem to activate regions of the anterior temporal lobes if abstract person-related content is communicated by speech and gesture. These new findings illustrate the complexity of interpersonal communication, as our data demonstrate that multisensory information pathways interact at both perceptual and semantic levels.

- Teufel, C., Alexis, D. M., Clayton, N. S., & Davis, G. (2010). [Mental-state attribution drives rapid, reflexive gaze following](#). *Attention, Perception, & Psychophysics*, 72, 695-705.

Abstract

When presented with a face stimulus whose gaze is diverted, observers' attention shifts to locations fixated by the face. Such "gaze following" has been characterized by some previous studies as a consequence of sophisticated theory of mind processes, but by others (particularly those employing the "gaze-cuing" paradigm) as an involuntary response that is triggered directly and reflexively by the physical features of a face. To address this apparent contradiction, we modified the gaze-cuing paradigm using a deception procedure to convince observers that prerecorded videos of an experimenter making head turns and wearing mirrored goggles were a "live" video link to an adjacent room. In two experiments, reflexive gaze following was found when observers believed that the model was wearing transparent goggles and could see, but it was significantly reduced when they believed that the experimenter wore opaque goggles and could not see. These results indicate that the attribution of the mental state "seeing" to a face plays a role in controlling even reflexive gaze following.

- **NY!** Van Overwalle, F. (2010). [A dissociation between social mentalizing and general reasoning](#). *NeuroImage*. Tidig elektronisk publicering.

Abstract

It has recently been suggested that brain areas crucial for mentalizing, including the medial prefrontal cortex (mPFC), are not activated exclusively during mentalizing about the intentions, beliefs, morals or traits of the self or others, but also more generally during cognitive reasoning including relational processing about objects. Contrary to this notion, a meta-analysis of cognitive reasoning tasks demonstrates that the core mentalizing areas are not systematically recruited during reasoning, but mostly when these tasks describe some human agency or general evaluative and enduring traits about humans, and much less so when these social evaluations are absent. There is a gradient showing less mPFC activation as less mentalizing content is contained in the stimulus material used in reasoning tasks. Hence, it is more likely that cognitive reasoning activates the

mPFC because inferences about social agency and mind are involved.

- **NY!** Vistoli, D., Brunet-Gouet, E., Baup-Bobin, E., Hardy-Bayle, M. C., & Passerieux, C. (2010). [Anatomical and temporal architecture of theory of mind: A MEG insight into the early stages.](#) *NeuroImage*. Tidig elektronisk publicering.

Abstract

Representation of others' actions and mental states leads to the activation of several brain networks: the mentalizing and the "mirror neuron" systems as well as a "low level" social perception component. However, respective activations of the regions belonging to these networks remain unknown with respect to chronometrical data when static drawing stimuli are presented. To determine anatomical and temporal characteristics of theory of mind processes, magnetic signals were measured in 21 subjects during a validated nonverbal attribution of intentions task. Minimum norm estimation provides chronometric and localization data showing that regions known to be involved in the mentalizing, "mirror neuron" and social perception networks have simultaneous activations between 100 and 700 ms post-stimulus, a period which may be thought as corresponding to early stages of social processes. Among some regions, different profiles as well as modulations regarding experimental conditions suggest functional distinctions between these structures, pleading for a cooperative nature of these networks. While the left temporo-parietal area and superior temporal sulcus seem more specialized in social cues coding, we demonstrate that their right homologues, as well as the right inferior parietal cortex, are preferentially recruited during attribution of intentions stimuli compared to scenarios based on physical causality from 200 to 600 ms.

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

Abstract

Theory of Mind (ToM), the ability to attribute mental states to others, and empathy, the ability to infer emotional experiences, are important processes in social cognition. Brain imaging studies in healthy subjects have described a brain system involving medial prefrontal cortex, superior temporal sulcus and temporal pole in ToM processing. Studies investigating networks associated with empathic responding also suggest involvement of temporal and frontal lobe regions. In this fMRI study, we used a cartoon task derived from Sarfati et al. (1997) [Sarfati, Y., Hardy-Bayle, M.C., Besche, C., Widlocher, D. 1997. Attribution of intentions to others in people with schizophrenia: a non-verbal exploration with comic strips. *Schizophrenia Research* 25, 199-209.] with both ToM and empathy stimuli in order to allow comparison of brain activations in these two processes. Results of 13 right-handed, healthy, male volunteers were included. Functional images were acquired using a 1.5 T Phillips Gyroscan. Our results confirmed that ToM and empathy stimuli are associated with overlapping but distinct neuronal networks. Common areas of activation included the medial prefrontal cortex, temporoparietal junction and temporal poles. Compared to the empathy condition, ToM stimuli revealed increased activations in lateral orbitofrontal cortex, middle frontal gyrus, cuneus and superior temporal gyrus. Empathy, on the other hand, was associated with enhanced activations of paracingulate, anterior and posterior cingulate and amygdala. We therefore suggest that ToM and empathy both rely on networks associated with making inferences about mental states of others. However, empathic responding requires the additional recruitment of networks involved in emotional processing. These results have implications for our understanding of disorders characterized by impairments of social cognition, such as autism and

psychopathy.

- **NY!** Wang, Y. W., Lin, C. D., Yuan, B., Huang, L., Zhang, W. X., & Shen, D. L. (2010). [Person perception precedes theory of mind: an event related potential analysis](#). *Neuroscience*, 170, 238-246.

Abstract

Prior to developing an understanding of another person's mental state, an ability termed "theory of mind" (ToM), a perception of that person's appearance and actions is required. However the relationship between this "person perception" and ToM is unclear. To investigate the time course of ToM and person perception, event-related potentials (ERP) were recorded while 17 normal adults received three kinds of visual stimuli: cartoons involving people (person perception cartoons), cartoons involving people and also requiring ToM for comprehension (ToM cartoons), and scene cartoons. We hypothesized that the respective patterns of brain activation would be different under these three stimuli, at different stages in time. Our findings supported this proposal: the peak amplitudes of P200 for scene cartoons were significantly lower than for person perception or ToM cartoons, while there were no significant differences between the latter two for P200. During the 1000–1300 ms epoch, the mean amplitudes of the late positive components (LPC) for person perception were more positive than for scene representation, while the mean amplitudes of the LPC for ToM were more positive than for person perception. The present study provides preliminary evidence of the neural dynamic that underlies the dissociation between person perception and ToM.

- Whitehead, C., Marchant, J. L., Craik, D., & Frith, C. D. (2009). [Neural correlates of observing pretend play in which one object is represented as another](#). *Social Cognitive and Affective Neuroscience*.

Abstract

Observers were scanned while they watched a video of an actor using an object. Three conditions were contrasted in which the same object was used: (i) normally (e.g. using a tennis racket to hit a ball), (ii) in an unusual way (e.g. using a tennis racket to strain spaghetti), (iii) in a pretend play (e.g. playing a tennis racket like a banjo). Observing real and unusual uses of objects activated areas previously seen in studies of tool use including areas associated with a mirror system for action. Observing pretend play activated additional areas previously associated with theory of mind tasks and listening to narrative, including medial prefrontal cortex, posterior superior temporal sulcus and temporal poles. After presentation of each video, observers were asked to name the object as used in the preceding action video (e.g. racket, sieve or banjo). Naming the pretend object elicited activity in medial prefrontal cortex. These results are consistent with proposals that pretend play is a form of communicative narrative, associated with the ability to mentalize. However, this leaves open the question as to whether pretence or mentalizing is the more basic process.

- **NY!** Yoshida, W., Seymour, B., Friston, K. J., & Dolan, R. J. (2010). [Neural Mechanisms of Belief Inference during Cooperative Games](#). *Journal of Neuroscience*, 30, 10744-10751.

Abstract

Humans have the arguably unique ability to understand the mental representations of others. For success in both competitive and cooperative interactions, however, this ability must be extended to include representations of others' belief about our intentions,

their model about our belief about their intentions, and so on. We developed a "stag hunt" game in which human subjects interacted with a computerized agent using different degrees of sophistication (recursive inferences) and applied an ecologically valid computational model of dynamic belief inference. We show that rostral medial prefrontal (paracingulate) cortex, a brain region consistently identified in psychological tasks requiring mentalizing, has a specific role in encoding the uncertainty of inference about the other's strategy. In contrast, dorsolateral prefrontal cortex encodes the depth of recursion of the strategy being used, an index of executive sophistication. These findings reveal putative computational representations within prefrontal cortex regions, supporting the maintenance of cooperation in complex social decision making.

Teori

- Knox, J. (2009). [Mirror neurons and embodied simulation in the development of archetypes and self-agency](#). *Journal of Analytical Psychology*, 54, 307-323.

Abstract

In this paper I explore the role of mirror neurons and motor intentionality in the development of self-agency. I suggest that this will also give us a firmer basis for an emergent view of archetypes, as key components in the development trajectory of self-agency, from its foundation in bodily action to its mature expression in mentalization and a conscious awareness of intentionality. I offer some ideas about the implications of these issues of self-agency for our clinical work with patients whose developmental trajectory of self-agency has been partially inhibited, so that their communications have a coercive effect. I discuss the possibility that this kind of clinical phenomenon may relate to Gallese and Lakoff's hypothesis that abstract thought and imagination are forms of simulated action, and that the same sensory-motor circuits that control action also control imagination, concept formation and understanding, but with a crucial development, that of an inhibition of the connections between secondary pre-motor cortical areas and the primary motor cortex. I shall speculate that in the earlier developmental stages of self-agency, the separation of secondary from primary motor areas is not complete, so that imagination and thought are not entirely independent of physical action.

- Sasso, G. (2009). [Dynamic sensory-motor oscillation and cerebral development](#). *Cognitive Processing*.

Abstract

Drawing from Freud's *Project*, the author proposes a model of cerebral development whose sensory-motor structure is defined by a frontal-occipital oscillatory dynamic with a twofold function: the oscillation explains the formation and maintenance of mother-infant attunement in cerebral growth, while, at the same time, also explaining the functioning of the projective-introjective dynamic at the basis of psychoanalytic theory. The oscillatory dynamic, according to this perspective, operates as a "bridge" between two seminal theoretical models of developments—the psychoanalytic and the infant research model—which, in turn, leads to the formulation of some neurological hypotheses on how oscillation regulates the elaboration of maternal interaction in the infant's brain, and how the mother may act to modify it. The paper discusses how the oscillatory dynamic offers an innovative framework for the reconceptualization of the development of mentalization, the function of mirror neurons, and, most interestingly, of the development of language, explaining the non-verbal properties of ordinary linguistic communication and the function of oscillation in the regulation of information exchange processing.

Patologi

Forskning

- Bodden, M. A., Mollenhauer, B., Trenkwalder, C., Cabanel, N., Eggert, K. M., Unger, M. M., Oertel, W. H., Kessler, J., Dodel, R., & Kalbe, E. (2010). [Affective and cognitive theory of mind in patients with parkinson's disease](#). *Parkinsonism & Related Disorders*, 16, 466-470.

Abstract

Theory of Mind (ToM), which is the ability to infer other people's mental states such as beliefs or desires, is an important prerequisite for social interaction. Affective and cognitive subcomponents of ToM can be impaired selectively in neurological and psychiatric disorders. This study examines ToM in 21 Parkinson's disease (PD) patients and 21 healthy control (HC) subjects, using the computerized "Yoni task" that assesses affective and cognitive ToM abilities and an extensive battery of neuropsychological tests. Furthermore, questionnaires to assess health-related quality of life and depressive symptoms were applied and correlations to ToM were investigated. Compared to the control subjects, PD patients scored lower on both the affective (PD: 76% versus HC: 89%; $p = 0.006$) and cognitive (PD: 80% versus HC: 92%; $p = 0.002$) ToM subscales but not on control items (PD: 90% versus HC: 95%; $p = 0.077$). The ToM abilities were not associated with other cognitive functions, depressive symptoms or clinical data. However, affective ToM was correlated with health-related quality of life ($p = 0.01$). Parkinson patients are impaired in affective as well as cognitive ToM. These deficits are largely independent from other cognitive impairments, depressive symptoms and motor impairment. The relationship of affective ToM to the health-related quality of life of PD patients points to a clinical relevance of this issue and suggests that ToM dysfunctions must be regarded as an important non-motor feature of Parkinson's disease.

- Carlo, L., Silvia, D., Calcagni, M. L., Bruno, I., & De Risio, S. (2007). [Neural correlates of psychodynamic psychotherapy in borderline disorders: A pilot investigation](#). *Psychotherapy and Psychosomatics*, 76, 403-405.
- Fyfe, S., Williams, C., Mason, O. J., Pickup, G. J. (2008). [Apophenia, theory of mind and schizotypy: Perceiving meaning and intentionality in randomness](#). *Cortex*, 44, 1316-1325.

Abstract

Impaired ability to correctly infer others' mental states ('Theory of Mind' – ToM) and the tendency to perceive meaning in unrelated events ('apophenia') have been implicated in vulnerability to schizophrenia. Sixty-three healthy participants completed three experimental tasks that provided indices of ToM and apophenia. The first task (Contingency) required participants to rate the strength of relationship between the movements of two shapes; in some conditions the movements were unrelated, in others the movement of one shape was contingent on that of the other. In the second task (Stories), participants answered questions on short stories with 'random', 'physical' or 'ToM' themes. The third task (Triangles) required participants to view and then describe the movement of triangles on a computer screen in 'random', 'physical' and 'ToM' conditions. Participants completed questionnaire measures of psychosis-proneness (the Schizotypal Personality Scale – STA) and delusional thinking style (Peters et al. Delusions Inventory – PDI-21). Little evidence was found on any of the tasks for an association between a specific deficit in ToM accuracy and any aspect of psychosis-proneness. On the Triangles task, schizotypal and delusion-prone participants spontaneously reported perceiving a greater number of associations in the random condition (apophenia). On both the Triangles and Contingency tasks, over-mentalizing was found to be associated with delusional thinking but not with general schizotypy. We speculate that over-mentalizing may be underpinned by a hyper-associative cognitive

style, linked to an exaggeration of the normal human tendency to attribute mental states, rather than to dysfunction in the assessment of causality. Perceiving meaning in randomness and, more particularly, attributing mental states where none are indicated, may be important factors in the formation of paranormal and delusional beliefs.

- **[Fulltext via länk]** Gilbert, S. J., Meuwese, J. D., Towgood, K. J., Frith, C. D., & Burgess, P. W. (2009). [Abnormal functional specialization within medial prefrontal cortex in high-functioning autism: A multi-voxel similarity analysis](#). *Brain*, 132, 869-878.

Abstract

Multi-voxel pattern analyses have proved successful in 'decoding' mental states from fMRI data, but have not been used to examine brain differences associated with atypical populations. We investigated a group of 16 (14 males) high-functioning participants with autism spectrum disorder (ASD) and 16 non-autistic control participants (12 males) performing two tasks (spatial/verbal) previously shown to activate medial rostral prefrontal cortex (mrPFC). Each task manipulated: (i) attention towards perceptual versus self-generated information and (ii) reflection on another person's mental state ('mentalizing' versus 'non-mentalizing') in a 22 design. Behavioral performance and group-level fMRI results were similar between groups. However, multi-voxel similarity analyses revealed strong differences. In control participants, the spatial distribution of activity generalized significantly between task contexts (spatial/verbal) when examining the same function (attention/mentalizing) but not when comparing different functions. This pattern was disrupted in the ASD group, indicating abnormal functional specialization within mrPFC, and demonstrating the applicability of multi-voxel pattern analysis to investigations of atypical populations.

- Gillberg, I. C., Billstedt, E., Wentz, E., Anckarsater, H., Råstam, M., & Gillberg, C. (2009). [Attention, executive functions, and mentalizing in anorexia nervosa eighteen years after onset of eating disorder](#). *Journal of Clinical and Experimental Neuropsychology*.

Abstract

Objective: Prospective study of attention, executive functions, and mentalizing abilities in a representative sample of teenage-onset anorexia nervosa (AN). *Method:* A total of 51 AN cases recruited after community screening were contrasted with 51 matched comparison cases 18 years after AN onset. Neuropsychological tests had been done at 21, 24, and 32 years (18 years after AN onset). *Results:* The AN-group had more attention, executive function, and mentalizing problems. Some of these problems had been present at all three follow-up occasions. *Conclusions:* AN is associated with a range of neuropsychological problems that are present long after the eating disorder per se is no longer an important feature.

- Lee, T. M. C., Ip, A. K. Y., Wang, K., Xi, C. H., Hu, P. P., Mak, H. K. F., Han, S. H., & Chan, C. C. H. (2010). [Faux pas deficits in people with medial frontal lesions as related to impaired understanding of a speaker's mental state](#). *Neuropsychologia*.

Abstract

This study examined the nature of deficits in mentalizing, the ability to read the mental state of other people, as measured by a faux pas task in people with medial frontal lesions. A total of 56 Mandarin-speaking Chinese individuals participated (9 participants with medial frontal lesions, 12 participants with lateral frontal lesions, 5 participants with non-frontal lesions, and 30 healthy controls). The faux pas test ascertained the participants' ability to identify and understand a social faux pas, and to understand the

mental states of the characters (the speaker and the recipient in a conversation with a social faux pas). Although the participants with medial frontal lesions performed less well than the other clinical participants and the control participants on all aspects of the faux pas test, the most significant deficit was observed in understanding mental states and hence inferring the speaker's intentions. The performance on the various aspects of decoding a social faux pas by people with medial frontal lesions suggests that the cognitive processes, and hence the respective neural correlates subserving these various processes, may be different. Our results add to existing literature and illustrate the very nature of deficits of mentalizing, measured by a faux pas test, experienced by people with medial frontal lesions. The data have also prompted that future behavioral and neuroimaging studies may be applied to further decode both the neural mechanisms and the cognitive variables affecting "mentalizing".

- **[Fulltext via länk]** Lombardo, M. V., Chakrabarti, B., Bullmore, E. T., Sadek, S. A., Suckling, J., & Baron-Cohen, S. (2009). [Atypical neural self-representation in autism](#). *Brain*.

Abstract

The 'self' is a complex multidimensional construct deeply embedded and in many ways defined by our relations with the social world. Individuals with autism are impaired in both self-referential and other-referential social cognitive processing. Atypical neural representation of the self may be a key to understanding the nature of such impairments. Using functional magnetic resonance imaging we scanned adult males with an autism spectrum condition and age and IQ-matched neurotypical males while they made reflective mentalizing or physical judgements about themselves or the British Queen. Neurotypical individuals preferentially recruit the middle cingulate cortex and ventromedial prefrontal cortex in response to self compared with other-referential processing. In autism, ventromedial prefrontal cortex responded equally to self and other, while middle cingulate cortex responded more to other-mentalizing than self-mentalizing. These atypical responses occur only in areas where self-information is preferentially processed and does not affect areas that preferentially respond to other-referential information. In autism, atypical neural self-representation was also apparent via reduced functional connectivity between ventromedial prefrontal cortex and areas associated with lower level embodied representations, such as ventral premotor and somatosensory cortex. Furthermore, the magnitude of neural self-other distinction in ventromedial prefrontal cortex was strongly related to the magnitude of early childhood social impairments in autism. Individuals whose ventromedial prefrontal cortex made the largest distinction between mentalizing about self and other were least socially impaired in early childhood, while those whose ventromedial prefrontal cortex made little to no distinction between mentalizing about self and other were the most socially impaired in early childhood. These observations reveal that the atypical organization of neural circuitry preferentially coding for self-information is a key mechanism at the heart of both self-referential and social impairments in autism.

- Minio-Paluello, I., Baron-Cohen, S., Avenanti, A., Walsh, V., & Aglioti, S. M. (2009). [Absence of embodied empathy during pain observation in asperber syndrome](#). *Biological Psychiatry*, 65, 55-62.

Abstract

Background

Asperger syndrome (AS) is a neurodevelopmental condition within the autism spectrum conditions (ASC) characterized by specific difficulties in communication, social interaction, and empathy that is essential for sharing and understanding others'

feelings and emotions. Although reduced empathy is considered a core feature of ASC, neurophysiological evidence of empathic deficits before and below mentalizing and perspective taking is lacking. We explored whether people with AS differ from neurotypical control participants in their empathic corticospinal response to the observation of others' pain and the modulatory role played by phenomenal experience of observed pain and personality traits.

Methods

Sixteen right-handed men with AS (aged 28.0 ± 7.2 years) and 20 neurotypical controls (aged 25.3 ± 6.7 years) age, sex, and IQ matched, underwent single-pulse transcranial magnetic stimulation during observation of painful and nonpainful stimuli affecting another individual.

Results

When observing other's pain, participants with AS, in contrast to neurotypical control participants, did not show any amplitude reduction of motor-evoked potentials recorded from the muscle vicariously affected by pain, nor did their neurophysiological response correlate with imagined pain sensory qualities. Participants with AS represented others' pain in relation to the self-oriented arousal experienced while watching pain videos.

Conclusions

Finding no embodiment of others' pain provides neurophysiological evidence for reduced empathic resonance in people with AS and indicates that their empathic difficulties involve not only cognitive dimensions but also sensorimotor resonance with others. We suggest that absence of embodied empathy may be linked to changes at very basic levels of neural processing.

- **[NY]** Park, I. H., Ku, J., Lee, H., Kim, S. Y., Kim, S. I., Yoon, K. J., & Kim, J. J. (2010). [Disrupted theory of mind network processing in response to idea of reference evocation in schizophrenia](#). *Acta Psychiatrica Scandinavica*. Tidig elektronisk publicering.

Abstract

Objective: This study examined the neural pathophysiology of the theory of mind network by eliciting self-referential processing during an idea of reference evocating situation in patients with schizophrenia.

Method: Functional MRI was conducted on 14 schizophrenic in-patients with the idea of reference and 15 healthy participants while viewing video vignettes of referential conversations, non-referential conversations or no conversations between two people, which were filmed at varying distances of 1, 5 or 10 m.

Results: The patient group did not show normal patterns of superior temporal sulcus activation to conversational context, and reciprocal deactivation and activation of the ventromedial and dorsomedial prefrontal cortex to referential conversational context. Instead, the patient group showed overall greater ventromedial prefrontal activities across different conversational contexts and inverse correlation between superior temporal sulcus activity and delusional severity. Differential activations of the temporal pole and its posterior extension to varying distances were observed in the control group but not in the patient group.

Conclusion: The present study demonstrates that theory of mind-related responses of the medial prefrontal-superior temporal network are attenuated during the self-referential processing in patients with schizophrenia and that these abnormalities may be related to the formation of their referential or persecutory delusion.

- **[Fulltext via länk]** Paulesu, E., Sambugaro, E., Torti, T., Danelli, L., Ferri, F., Scialfa, G., et al. (2009). [Neural correlates of worry in generalized anxiety disorder and in normal controls: A functional MRI study](#). *Psychological Medicine*.

Abstract

Background. Worry is considered a key feature of generalized anxiety disorder (GAD), whose neural correlates are poorly understood. It is not known whether the brain regions involved in pathological worry are similar to those involved in worry-like mental activity in normal subjects or whether brain areas associated with worry are the same for different triggers such as verbal stimuli or faces. This study was designed to clarify these issues.

Method. Eight subjects with GAD and 12 normal controls underwent functional magnetic resonance imaging (fMRI) mood induction paradigms based on spoken sentences or faces. Sentences were either neutral or designed to induce worry. Faces conveyed a sad or a neutral mood and subjects were instructed to empathize with those moods.

Results. We found that the anterior cingulate and dorsal medial prefrontal cortex [Brodmann area (BA) 32/23 and BA 10/11] were associated with worry triggered by sentences in both subjects with GAD and normal controls. However, GAD subjects showed a persistent activation of these areas even during resting state scans that followed the worrying phase, activation that correlated with scores on the Penn State Worry Questionnaire (PSWQ). This region was activated during the empathy experiment for sad faces.

Conclusions. The results show that worry in normal subjects and in subjects with GAD is based on activation of the medial prefrontal and anterior cingulate regions, known to be involved in mentalization and introspective thinking. A dysregulation of the activity of this region and its circuitry may underpin the inability of GAD patients to stop worrying.

- Shamay-Tsoory, S. G., Harari, H., Aharon-Peretz, J., & Levkovitz, Y. (2009). [The role of orbitofrontal cortex in affective theory of mind deficits in criminal offenders with psychopathic tendencies.](#) *Cortex*.

Abstract

Individuals with psychopathy show impaired emotional and social behavior, such as lack of emotional responsiveness to others and deficient empathy. However, there are controversies regarding these individuals' theory of mind (ToM) abilities and the neuroanatomical basis of their aberrant social behavior. The present study tested the hypothesis that impairment in the emotional aspects of ToM (affective ToM) rather than general ToM abilities may account for the impaired social behavior observed in psychopathy and that this pattern of performance may be associated with orbitofrontal cortex (OFC) dysfunction.

To assess the emotional and cognitive aspects of ToM we used a task that examines affective versus cognitive ToM processing in separate conditions. ToM abilities of criminal offenders diagnosed with antisocial personality disorder with high psychopathy features were compared to that of participants with localized lesions in the OFC or dorsolateral, participants with non-frontal lesions, and healthy control subjects. Individuals with psychopathy and those with OFC lesions were impaired on the 'affective ToM' conditions but not in cognitive ToM conditions, compared to the control groups. It was concluded that the pattern of mentalizing impairments in psychopathy resembles remarkably that seen in participants with lesions of the frontal lobe, particularly with OFC damage, providing support for the notion of amygdala–OFC dysfunction in psychopathy.

- Sripada, C. S., Angstadt, M., Banks, S., Nathan, P. J., Liberzon, I., & Phan, K. L. (2009). [Functional neuroimaging of mentalizing during the trust game in social anxiety disorder.](#) *NeuroReport*, 20, 984-989.

Abstract

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Individuals with generalized social anxiety disorder tend to make overly negative and distorted predictions about social events, which enhance perceptions of threat and contribute to excessive anxiety in social situations. Here, we coupled functional magnetic resonance imaging and a multiround economic exchange game ('trust game') to probe mentalizing, the social-cognitive ability to attribute mental states to others. Relative to interactions with a computer, those with human partners ('mentalizing') elicited less activation of medial prefrontal cortex in generalized social anxiety patients compared with matched healthy control participants. Diminished medial prefrontal cortex function may play a role in the social-cognitive pathophysiology of social anxiety.

- Walz, N. C., Yeates, K. O., Taylor, H. G., Stancin, T., & Wade, S. L. (2009). [First-order theory of mind skills shortly after traumatic brain injury in 3- to 5-year-old children](#). *Developmental Neuropsychology*, 34, 507-519.

Abstract

Post-acute effects of early childhood traumatic brain injury (TBI) on first-order theory of mind (ToM) skills were examined in 86 children with orthopedic injury (OI), 42 children with moderate TBI, and 17 children with severe TBI aged 3 to 5 years at the time of injury. Three-year-olds with TBI performed more poorly than 3-year-olds with OI on an appearance-reality task. The severe TBI group was impaired on false-contents tasks compared to the moderate TBI and OI groups. Age and IQ were strong predictors of ToM performance; however, the relationship between ToM and IQ was not as strong for children with TBI.