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REFLECTIONS

Reflections on empathy in medical education: What can we learn from social neurosciences?

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Abstract The role of empathy in human social interaction has been examined in several research fields, including medical education (ME) and social neuroscience (SN). SN yields insights into empathy based on neurobiological processes, and such information may also be relevant to ME. In this reflection article, the authors first critically review current definitions and concepts of empathy in ME and link them to recent SN findings. In the light of recent evidence from SN, research in ME regarding the positive and negative effects of empathy for physicians and patients is discussed, as well as the question whether (future) physicians differ from the general population with regard to empathic skills. Commonly used SN paradigms and ME approaches to assess empathy are contrasted, a joint approach is advocated, and implications for further interdisciplinary studies are outlined. Finally, the authors delineate the contribution of SN to the question of whether empathy is teachable, and argue that SN findings represent a potential for new ME training approaches. In conclusion, the authors discuss how the incorporation of perspectives on empathy from different research areas would benefit ME, and suggest the translation and integration of such findings into ME research approaches.

Keywords Empathy · Medical education · Social neurosciences · Physician–patient relationship · Assessment · Training · Pain

The body of research on empathy in medical education (ME) is rapidly growing; topics such as the nature of empathy (Hojat 2007), its various definitions (Halpern 2003), different assessment approaches (Pedersen 2009), its value for clinical practice, (Shapiro 2011) training programs (Stepien and Baernstein 2006), and outcome factors (Neumann

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et al. 2007) have been explored. The majority of scholars emphasize two facets when introducing the concept of empathy: (1) empathy is essential in clinical practice and for physicians (e.g., Hojat et al. 2002a, b; Mercer and Reynolds 2002; Neumann et al. 2009; Shapiro 2008); (2) there appears to be more disagreement than agreement among researchers about the definition of empathy [e.g., (Hojat 2007)].

This dissension is not unique to ME research: several other research areas, such as psychology and medicine, are laden with multiple definitions of empathy, leading to similar confusion regarding the concept of empathy, appropriate assessment instruments, and inconsistent results. Indeed, it has been stated that "in many studies that present or use empathy measures, empathy is not defined, and even among those in which empathy is defined, it is often not explicitly stated how the concept of empathy relates to cognitive and emotional aspects" (Pedersen 2009, p. 316). The use of the same terminology might suggest the same underlying definitions, yet this is actually not the case. Therefore, different study results with various empathy definitions cannot be easily compared or integrated, and conclusive evidence on empathy cannot be gained. This shortcoming and limitation of progress in the field can only be overcome by clarifying the different connotations and implications of the terms one is using.

What might resolve this situation? Apart from clearly communicating one's definition of empathy and explicitly aligning that definition with corresponding assessment methods, we propose that empathy be examined from another research angle that has a consistent and clear definition of empathy: social neuroscience (SN). In SN, empathy is broadly defined (see Singer and Lamm 2009 for a detailed discussion) as a social emotion that allows an observer to feel what another person is feeling, with a clear distinction between the self and another. This "feeling as" definition helps to distinguish empathy from related concepts such as emotion contagion (a basic perceptual mechanism that can result in full-blown empathy, but should not be equated with it) and compassion, sympathy, or empathic concern, which are "feeling for" social emotions (i.e., emotions which do not only co-represent the feeling of the other, but also contain a motivational component, such as the willingness and intention to alleviate the suffering of the other person).

Since the first high-impact neuroimaging study of empathy in 2004 (Singer et al. 2004), the field of SN has continued to grow and provide interesting insights into the neurobiological basis of understanding and sharing the emotions of others through the cognitive and affective mechanisms of empathy (Lieberman 2012). However, despite several recent SN reports wherein study findings were explained in relation to the professional routine of physicians (Gleichgerrcht and Decety 2012, 2013; Halpern 2012; Newton 2013), the majority of SN findings have not been yet translated into implications for the field of ME (with the fundamental exception of Halpern 2012, highlighting "The Paradox of Teaching Empathy in Medical Education"). In this opinion paper, we analyze similarities and differences between ME and SN research regarding the definition, assessment, outcome, and training of empathy. We aim to initiate a more robust connection between both fields, and to explore whether and how SN findings could enrich ME empathy research and, subsequently, implementations fostering medical students' empathy by tailored curricula.

Does SN support the views and definitions of empathy in ME?

Given the multiple definitions of empathy, scholars within ME nowadays tend to define empathy more thoroughly. Regardless of the definition, it is crucial that ME researchers indicate the nature of empathy (affective or cognitive, or affective and cognitive) inherent in their perspective, as these two presumptions draw upon different underlying frameworks that yield extensive consequences (e.g., for assessment, effective training methods, outcomes for patients and/or physicians).

Taken together, two main parties exist, and each places a different emphasis on the nature of empathy: supporters of a more cognitive definition, and advocates of a more affective definition.

Several ME researchers such as Halpern, Newton, Shapiro, and Spiro emphasize the affective aspects of empathy (Halpern 2012; Newton et al. 2008; Shapiro 2011, 2012; Spiro 2009). These researchers assert that empathy involves more than just the cognitive comprehension of an emotion. This view of the affective aspect of empathy is supported by SN, as the majority of SN scholars define empathy as an ability to share the emotions of others while maintaining full awareness that the emotions experienced were triggered by the other individual (for a comprehensive overview of the different concepts and definitions, see Singer and Lamm 2009). Notably, this definition of empathy is supported by neuroimaging evidence suggesting that empathy engages brain areas linked to the awareness and regulation of emotions, such as the medial cingulate and anterior insular cortex (see Lamm et al. 2011; Fan et al. 2011 for recent meta-analyses).

Conversely, empathy in the ME field is typically defined in relation to the cognitive components, while little importance is assigned to the affective components (e.g., Hojat 2007; Mercer and Reynolds 2002). Given the plethora of theoretical and empirical evidence for the intrinsically affective nature of empathy, this definition is outdated from a SN perspective; however, recent studies published in ME journals have nonetheless focused on a cognitive definition of empathy, albeit only implicitly through the use of certain assessment instruments that are based on a cognitive definition of empathy, e.g., the Jefferson Scale of Physician Empathy (JSPE) (see e.g., Berg et al. 2011; Canale et al. 2012; Hojat et al. 2011).

Cognitive definitions of empathy may be favored for several reasons. First, the focus on cognitive mechanisms has several connotations. If empathy is cognitive, it may be perceived as a skill that is acquired over time with practice, rather than an innate trait; it follows that empathy can be trained by methods such as communication techniques (e.g., active listening or addressing patients' emotions). Furthermore, if cognitive empathy were a skill, it would presumably translate into a behavior rather than into an attitude, and could consequently be measured more objectively (e.g., through observation rather than self-report ratings of an experienced emotion).

Regarding the manifestation of empathy as a behavior, SN definitions of empathy encompass cognitive mechanisms (e.g., Zaki and Ochsner 2012), but in combination with affective processes: in fact, the majority of models emphasize that the intrinsic interaction between cognitive and affective processes shapes a full-blown empathic response (e.g., Decety and Jackson 2004; Decety and Lamm 2006; Zaki and Ochsner 2012); (see also Lamm and Majdandžić 2014, for recent discussion). For example, the neurocognitive abilities to regulate emotion and distinguish between self and other are fundamental to empathy, particularly in situations that might result in distress or vicarious over-arousal. Vicarious over-arousal describes the fact that observing someone else in aversive states such as pain can result in emotional and autonomic arousal that is so strong that the observer is not able to regulate it appropriately. This might, then, negatively impact the emotional and bodily state of the observer and result for instance in withdrawal from the social interaction (see for instance Decety and Lamm 2009). However, it is important to distinguish the mechanisms that enable the instigation of an empathic response from the

Table 1 Methods used in social neurosciences (based on Neumann and Westbury 2011)

Methods				
Based on central nervous system			Based on peripheral nervous system	
Neuroimaging techniques		Electroencephalography (EEG)	Electro dermal activity	Cardiovascular activity
Functional magnetic resonance imaging (fMRI)	Positron emission tomography (PET)	E.g., event-related potentials (ERPs)	E.g., skin conductivity	E.g., electrocardio-gram
Measurement				
Measures brain activation, permits the measurement of regional metabolism by detecting levels of oxygen in blood vessels and blood flow	Measures brain activation (like fMRI); more invasive due to the need to inject radioactive substances	Neurological test recording electrical activity in the brain: different types of waves (Alpha, beta, gamma delta) indicate individual's state and changes in that state	Measures changes in skin conductivity to an externally applied current	Measures the electrical activity of the heart
Aim				
Precise information about the spatial localization of the brain structures involved in empathy	(Like fMRI) with less spatial resolution	Short-term changes in EEG can be elicited to stimulus events; good temporal resolution	Responses are sensitive to e.g., sustained attention, stimulus significance, affective intensity of stimulus	Sensitivity to affective and attentional states
Main use in context of empathy and findings				
Pain response to other people experiencing pain or other aversive emotional states Empathy relies on a simulation of other's emotions: similar neural activation during empathy in brain areas also associated with direct experience of the emotion one is empathizing with		Brain wave that is associated with a response to a specific stimulus, such as a particular wave pattern observed when a patient observed pain in others	Provides an index of the degree of emotional responsiveness and attentional engagement to empathy-eliciting stimuli	In dyads: correlation between physiological synchrony of receiver and target and empathic accuracy
Possible implications for ME				
Knowledge of brain structures involved in empathy might help to incorporate definition with cognitive and affective aspects of empathy Own emotion experience of physicians as well as ability to regulate own emotions crucial for empathic experience		Training for medical students to reduce the time between affective automatic response and cognitive down-regulation in surgery procedures	In a communication setting, physicians can self-experience or observe real-time physiological responses of both members of a physician–patient dyad The degree to which patient and physician are physiologically concordant or discordant with one another can be analyzed, leading to concrete suggestions of further training objectives in communication skills courses	

empathic response itself (see Lamm et al. 2011 and Singer 2006 for an in-depth discussion).

Another major advantage of emphasis on the cognitive basis of empathy for ME is the implication that the physician is in control of his/her empathy. If empathy is a skill and a behavior, the physician may choose to be empathetic or not in a certain situation; this decision would presumably be motivated by various factors (e.g., "more objectivity" through detachment) and yield outcomes for the physician and/or patient (e.g., burnout, distress, or compassion fatigue for the physician; reduced or increased compliance for the patient).

Nevertheless, SN studies indicate that (healthy) humans invariably experience an automatic (i.e., effortless and unconscious) response to the affective states of other persons (see e.g., Decety and Lamm 2006; Preston and de Waal 2002). These responses are grounded in the perception for action mechanisms, which enable us to rapidly "translate" others' behaviors into our own neural systems that mediate affective and behavioral regulation (Preston and de Waal 2002). This bottom-up neural processing rapidly engages affective responses, but can be modulated by top-down processes more closely related to cognitive components of empathy.

The affective and cognitive components of empathy, however, are not in opposition. For instance, engaging in perspective-taking (which has been linked to theory of mind or mentalizing; e.g., Perner and Lang 1999) can facilitate the apprehension of another person's (such as a patient) perspective, and result in the perceiver feeling and sensing what the other person is feeling and thinking.

Hence, recent SN empathy research indicates that the cognitive and affective aspects of empathy are not separate. This argument applies to empathy and current emotion theories in general, which stress that cognition and emotion are not opposing players (Scherer et al. 2001). Rather, they are intrinsically intertwined, and ideally interact in concert during decision-making and other evaluative processes. In our opinion, the perspective on empathy in ME should adhere to these findings from SN: We suggest that the affective basis for empathy should be acknowledged as an important foundation of empathy and we wish to stimulate a shift in focus towards this aspect in definitions and studies of empathy. Cognitive mechanisms, on the other hand, can help to handle these affective aspects of empathy. However, we suppose that the value of cognitive regulation has to be evaluated in regard to the specific requirements in different clinical care situations (e.g., one could argue that fast and full cognitive regulation is essential for situations in which time-sensitive appropriate procedural functioning is required from the physician, such as for instance during surgical procedures. On the other hand, there are situations where such regulation may be counterproductive. For instance, effective communication between physician and patient requires to use affective aspects of empathy to develop rapport, i.e., a sense of affective connectedness between physician and patient. Too extensive cognitive regulation might deprive the physician of noticing important affective and non-verbal cues communicated by the patient and therefore act against the development of such rapport).

Findings on outcomes of empathy

The outcome of empathy has been the subject of several ME studies (see e.g., Neumann et al. 2007, 2009; Rakel et al. 2011). Although it seems difficult to compare studies on the outcome of empathy in ME, because their definitions of empathy and methodology differ, empathy consistently has been linked to several positive outcomes. More specifically, ME studies have demonstrated that exhibition of empathy by physicians increases patient trust [in line with the process model of empathy, incorporating affective and cognitive aspects (Norfolk et al. 2007)], improves patient satisfaction, increases therapy adherence, and improves clinical outcomes (e.g., Canale et al. 2012; Di Blasi et al. 2011; Hojat et al. 2011; Rakel et al. 2011; all of them using a more cognitive definition of empathy). Moreover, empathic physicians are less likely to experience burnout and compassion fatigue (Brazeau et al. 2010; Gleichgerrcht and Decety 2013).

Conversely, excessive empathy in medicine and in ME has been presented as a potential obstacle in clinical encounters because of possible negative outcomes for the physician, such as becoming too involved in the patient's distress (cf. 'costs of being too empathic', Gleichgerrcht and Decety 2012). Given this, physicians are often advised to remain detached from patients. As early as 1967, the struggle of physicians and medical students to balance detached objectivity with a capacity for deep empathy has been described (MacLean 1967). This struggle still exists. Although there is a wealth of literature regarding empathy, proper instruction for students and residents in balancing empathy and objectivity does not yet exist (as described recently by Shapiro 2011). Detachment, emotional distance, and clinical neutrality were and still are promoted within ME to prevent physicians from becoming too involved with patients' emotions and possibly becoming incapable of providing adequate care (for the concept of "detached concern," see e.g., Halpern 2012). This view of detachment is in stark contrast with recent perspectives of emotions, including empathy (e.g., Scherer et al. 2001). These theories suggest that emotions are not forces or hindrances to be contained or controlled by cognition; rather, in the case of empathy, emotions are an important and diagnostic source of information on the internal state of another person that should not be ignored or dreaded. Similarly, one of the most interesting perspectives for the field of ME was proposed by Newton (2013), who argued that detachment should be regarded as a spectrum, and that a certain amount of detachment might prove useful.

Following this argument, and considering the necessity of distinguishing empathy from the empathic response itself, it may be informative to analyze which internal processes could promote different outcomes. In ME literature, emphasis had been placed on the awareness of the distinction between one's own emotions and the emotions of others ["as-if-condition," e.g. by Rogers (1975)]. This distinction has also been discussed in SN literature, which has stressed the importance of self-other distinction, and the ability to regulate vicariously experienced distressful emotions (e.g., Decety and Lamm 2009; Silani et al. 2013), which may either lead to positive (i.e., other-oriented "empathic concern") or negative outcomes (i.e., self-focused "personal distress"). For instance, Lamm et al. (2007) found that participants reported more empathic concern when imagining the pain of others, and more personal distress when imagining themselves to be in pain (see also Lamm et al. 2008). Empathic concern is defined as an other-oriented emotion elicited by the perceived welfare of another person (e.g., Batson 2009), and is associated with prosocial behavior and altruism (e.g., Hein et al. 2010, 2011). Conversely, personal distress represents a negative outcome of empathy when the self-other distinction is blurred, and possibly leads to reactions that are detrimental to empathic concern as well as other-oriented helping behavior, e.g., by resulting in attempts to reduce personal stress by withdrawing from the stressor (Decety and Lamm 2009). Drawing on these findings, ME could focus more on the physicians' or medical students' skills to distinguish their emotions from those of their clients—as successful self-other distinction might serve as an interesting variable for empathy outcome studies as well as a potential starting point for training empathy.

Assessment of empathy: differences between SN and ME

Assessment methods for empathy are plentiful in ME, and their quality with regard to reliability and validity has been discussed elsewhere (e.g., Hemmerdinger et al. 2007; Pedersen 2009; Yu and Kirk 2009). Again, it should be emphasized that a given assessment method should be associated with a specific definition of empathy, and that its validity depends on the context for which it was developed. For example, an assessment instrument that was developed for the general population would not necessarily be valid when used on a very specific population, such as physicians.

When an affective definition of empathy is used, self-ratings of empathic attitude are considered state-of-the-art in ME, and often combined with qualitative approaches in study designs (e.g., narratives, reflective tasks). In contrast, defining empathy as a cognitive or a behavioral trait often leads to studies that intertwine empathy with physician–patient communication. This is also the setting where observational methods in ME are frequently used to assess empathic behavior.

Empathy in SN research is assessed quite differently, with various techniques and based on diverse structures like the central or peripheral nervous system (see Table 1, based on Neumann et al. 2011).

Owing to the requirements of neuroscientific methods and their experimental approach of replicable and standardized measurement conditions and stimuli, SN has predominantly exposed participants to abstract and standardized situations, such as pictures or videos of other persons in aversive states (for recent overview see the meta-analyses by Lamm et al. 2011; Fan et al. 2011). While such an approach ignores the complexity and interactivity of social interactions, it does enable the detection of fundamental and domain-general empathy mechanisms that extend beyond the idiosyncrasy of individual interactions. This approach has also been exploited to assess the neural responses of physicians while treating a patient (Jensen et al. 2013) and it was shown that physician treatment involves several neural representations, and that one of them is empathy towards the patient. Future experiments should however attempt to bring the richness and complexity of our social world into the SN lab (Zaki and Ochsner 2012). For instance, an association between the communicative aspects of physicians' empathy and patients' empathy for pain was observed in a recent fMRI study (Sarinopoulos et al. 2013). In this study, nine female patients either had a 20-min clinician-centered or patient-centered interview with one physician (the latter including higher displayed physician empathy as assessed with the patient provider relationship questionnaire), followed by an fMRI pain tolerance study with the patient. The patient-centered interview was associated with a positive provider–patient relationship and reduced pain-related neural responses in the anterior insula when a picture of the empathic interviewer was presented. Although this is preliminary evidence (particularly given the small sample size), this study demonstrates the potential to link typical SN (pain) paradigms with patient-centered communication.

Do medical students and physicians differ from laypersons in their capacity for empathy?

We presently do not know whether medical students differ from laypersons with regard to empathy upon entry to medical school; however, some evidence suggests that the attitude towards physician empathy is more positive in first-year medical students than in the general population (e.g., Hojat et al. 2002a, b; Pedersen 2009). Nonetheless, there is fair amount of ME literature on whether and when a change in medical students' empathy occurs (Chen et al. 2007; Colliver et al. 2010a, b; Hojat et al. 2004, 2005, 2009, 2010; Neumann et al. 2011; Newton et al. 2008; Sherman and Cramer 2010). In general, evidence suggests medical students exhibit a decline in attitude towards empathy following practical experience, which usually occurs in the third year of the medical curriculum, relative to the first year (pre-clinical years). The factors underlying this decline are still subject to further research; however, the "hidden curriculum" with inadequate role models and distress are two of the most frequently mentioned effects of empathy decline.

As mentioned previously, neuroscience findings show that we seem equipped with a strong tendency to resonate automatically with others. Nevertheless, there is also evidence for individual differences in empathy-related neuronal responses. More specifically, studies comparing laypersons and physicians suggest a difference between these two groups with regard to the mechanisms of down-regulation of empathic responses: For example, in one study using fMRI (Cheng et al. 2007), observing acupuncture needles being inserted in different body parts resulted in higher activity in brain areas associated with regulatory mechanisms in experienced acupuncturists, compared to novice physicians and laypersons. Furthermore, the experts showed lower activation in brain regions associated with the automatic response to pain observation, and they also evaluated the pain observed by the patient to be significantly lower. Similar results regarding the down-regulation of pain empathy responses were obtained in another study measuring event-related potentials in internal medicine physicians (Decety et al. 2010).

In a large-scale study with practicing physicians, Gleichgerrcht and Decety (2013) concluded that regulating one's emotions (through perspective-taking, a cognitive aspect of empathy) is pivotal to the adaptive experience of empathy in clinical practice: different aspects of empathy, distress, burnout, altruistic behavior, emotional awareness, and well-being were assessed using validated instruments, and results indicated that low perspective-taking scores in combination with high levels of personal distress lead to compassion fatigue.

We do not know when expertise with regard to high levels of empathy occurs: is there a difference between medical students and the general population at the beginning, as self-report assessments on cognitive empathy suggest? What can be concluded about affective empathy: do future physicians react differently to the emotions of others and if so, in which way? Further, we still do not know which aspects of empathy develop or attenuate during medical training, or the nature of the underlying factors. We believe, however, that carefully conducted neuroimaging studies in combination with prospective questionnaire and experimental studies may provide valuable information on this matter. A better understanding of the development of cognitive and affective aspects of empathy is essential for medical educators: It can help them to determine the best time in medical curricula to implement tailored training programs to foster cognitive and affective aspects of empathy in order to enhance better outcomes in patients, medical students, and physicians alike.

Can SN findings on empathy be integrated into ME training?

The aim of ME research is to deepen the knowledge and understanding of learning, teaching and education, and ultimately translate this knowledge into medical practice (cf. translational studies focusing on implementation, see Ringsted et al. 2011). As we advocate for a holistic empathy definition in ME, we accordingly depict the ultimate goal of medical education to help medical students both to develop an attitude incorporating affective aspects of empathy and to learn adequate empathic behaviors by drawing more on cognitive aspects of empathy. In our opinion it is counterproductive for both the physician's and the patient's well-being if physicians are educated to display improved empathic behavior, without being also trained to experience and show the corresponding empathic attitude.

SN research yields insight into the mechanisms and processes that enable us to understand and share the emotions of others; however, the feasibility and processes associated with translating these insights into practical applications are not the main focus of SN. Yet, the majority of SN research programs are at least implicitly motivated by the exploration of the potential real-world impact of these insights.

Facilitating and supporting medical students' transition from a novice-level to an expert-level represents one of the challenges of medical curricula. It follows that the empathy of medical students should be cultivated in accordance with the requirements of a "good" doctor; this should ideally incorporate different assets, one of them being "professional" (e.g., Frank 2005; Swing 2007).

SN research suggests that both the affective aspects of empathy and its cognitive down- and up-regulation are subject to change, as a function of learning and experience. This is consistent with the assumption of ME training programs that the expression of empathy in the physician–patient relationship can be taught and learned. In ME, empathy training is often intertwined with communication skills training; the effectiveness of empathy training has been explored in several studies (e.g., Fernández-Olano et al. 2008). In these trainings, instruction is given for a certain behavior ("empathic behavior"), and typically consists of the training of specific phrases (e.g., 'I understand your anger') or labeling patients' emotions (e.g., Halpern 2012; Shapiro 2012). The receiver's (i.e., physician's) ability to accurately label the sender's (i.e., patient's) emotion is central to communication skills training, and is typically facilitated by using the feedback of standardized patients as an important teaching tool. Twenty years of research on empathic accuracy indicate that feedback on empathic accuracy leads to improvements in therapist empathy (for an overview, see Ickes 2011). However, in assessments such as the objective structured clinical examinations (OSCEs), the ability to accurately label perceived emotions still plays a minimal role, even though this ability is unquestionably more developed than simply detecting an emotion without sensing its quality.

SN has a rather long tradition of exploring the neurobiological bases of empathic accuracy. As shown by Levenson and Ruef (1992), empathic accuracy is higher when the observer and the observed person are in a state of physiological synchrony. Further, recent findings by Zaki et al. (2009) confirm that the mechanisms enabling empathic accuracy are indeed cognitive and based on networks associated with mentalizing and sensorimotor resonance. However, empathy training in ME does not necessarily only draw upon cognitive aspects of empathy. This is emphasized in recent reviews (see e.g., Batt-Rawden et al. 2013; Stepien and Baernstein 2006) that report the effectiveness and stability of empathy training are affected by the empathy definition, assessment instruments, and outcome measures used in the training. Training methods in ME that are based on an affective definition of empathy and designed to improve empathic attitude (DasGupta and Charon 2004), include approaches such as narratives or hospitalization experiences.

Interestingly, the necessity of a concrete definition of empathy might not be as relevant in practice as for the training approach. In a study by Shapiro (2002), the teaching methods of physicians in primary care settings were analyzed: the authors concluded that there may be an empathy continuum ranging from "attitudinal" to "behavioral." Regardless of the beliefs of the teachers about the nature of empathy, affective and behavioral training methods are combined in practice to teach empathy.

In contrast, training aimed toward the prevention of the target group from the negative outcomes of empathy is not, to our knowledge, formally integrated into medical curricula. Nonetheless, teaching medical students or inexperienced physicians how to "shut down" their emotions, leading to restricted empathy (or empathic behavior; "detachment"), is suspected to occur within the hidden curriculum (cf. the discussion of decline of empathy, e.g., Batt-Rawden et al. 2013; Chen et al. 2010; Colliver et al. 2010a, b; Hojat et al. 2004, 2010; Neumann et al. 2011; Sherman and Cramer 2010).

How may SN findings improve empathy training in physicians and medical students? Quite recently, there have been SN-based training programs that underpin the necessity of empathy with physiological measures in a communication setting. Riess and et al. (2011, 2012) developed such a neuroscience-informed training, and demonstrated an enhancement in neuroscience knowledge and patient-rated physician empathy and outcomes. Serving more as an objective approach in an experimental setting rather than a common assessment method, SN paradigms may yield insights on changes that occur during trainings. For instance, Klimecki et al. (2013a, b) and Leiberg et al. (2011) recently demonstrated that brief empathy and compassion trainings, using specific meditation techniques, induced changes in brain responses and promoted prosocial behaviors in response to the suffering of others. Notably, these changes could be interpreted as increased resilience and a consequently greater capacity to attend to the negative states of others. Hence, the fear within ME of "too much compassion/ empathy" may not be justified, as the acquisition of these skills could increase rather than decrease the emotional stability of the caregiver.

Conclusion

SN is a progressing research field with novel insights on empathy that may be integrated into existing ME approaches. SN lays the foundation for how empathy is implemented in our brain and mind. The knowledge generated by this emerging research discipline is therefore of direct relevance for the models of empathy and has direct practical implications for how empathy is related to social behavior and interaction. Hence, we have tried to argue in this paper that this evidence needs to be integrated into ME, whose use of the concept of empathy in many respects seems outdated and is not very evidence based. One concrete example to illustrate this discrepancy between what we know about empathy from SN and how ME is incorporating this knowledge is that case of affective versus cognitive aspects of empathy. SN has clearly shown that there are different neurobiological activities underlying affective versus cognitive empathy, and that from this different effects on social behavior and on patient–physician interaction can be predicted. In contrast, ME definitions on empathy are derived and developed more experience-based (e.g., using Delphi technique with groups of experts). Highlighting just one aspect of empathy (i.e., affective or cognitive) in ME definitions rather than taking both aspects together into account, may also have pragmatic reasons: For example, cognitive skills are more prone to change as a result of educational programs (Hojat 2007), whereas affective aspects are often seen as more innate and thus more difficult to change in an educational setting. Nonetheless, we advocate for a shift in ME to the more evidence based SN definitions of empathy. Further, SN research may help clarify the association between the cognitive and affective aspects of empathy. Given this, it is counterintuitive that, in ME, the cognitive and affective aspects of empathy are not yet considered interactive. In our opinion, ME research should strive for, or at least acknowledge, more holistic approaches. This should also be reflected in the choice of assessment instruments.

Implications of SN findings for assessment, training, and interpretation of regularly observed changes in empathy during the medical curriculum have been outlined in this paper and possible implications for ME are displayed in Table 1. Furthermore, and as a first step, it might prove useful to teach medical students in the curricula about the neurobiological basis of empathy in addition to the already well-established approach to see empathy (or empathic behavior) as a necessity of medical professionalism. However, we plead for more studies that apply SN findings to the pressing research questions regarding the effective training of affective and cognitive empathy. For instance, SN research might also help to understand in more detail which aspects of empathy are prone to cultural influences; this being essential when discussing international applicableness of educational approaches for fostering empathy or adapting assessment instruments to different cultures (see e.g., Preusche and Wagner-Menghin 2013). In this context for example, ME might profit from considering findings that neural resonance with ingroup vs. outgroup members (including people of different ethnicity; Avenanti et al. 2010; Riecansky et al. 2014; Sheng and Han 2012) as well as people who are similar vs. dissimilar to us strongly varies (e.g., Lamm et al. 2010; Perry et al. 2010).

However, there are several limitations: SN provides just a glimpse of neurobiological activity, and primarily as it relates to simple tasks like pain–no pain prompts. Moreover, (physician–patient) communication is very complex, and we do not yet understand the neural correlates of how empathy can improve such communication in medical students and physicians alike.

Nonetheless, future studies that combine SN and ME research questions may clarify whether the empathy of (novice) medical students differs from that of laypersons; when changes in empathy occur during medical curricula; and the possible neurobiological basis of these changes. Studies similar to those of Sarinopoulos et al. (2013) might yield greater insight on the concrete outcome of empathy. Furthermore, SN studies might also engender a new research field of empathy that has not been within the main focus of ME: What happens to physician empathy during pain-inducing procedures or operations? In conclusion, we believe it essential to examine empathy from different research angles (SN being one such angle) to achieve a more comprehensive understanding of empathy, and thus inspire new approaches to empathy research in ME.

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