

Paul J. Eslinger

Departments of Medicine (Division of Neurology) and Behavioral Science, Laboratory of Neuropsychology and Cognitive Neuroscience, College of Medicine, Penn State University, Hershey, Pa., USA

Neurological and Neuropsychological Bases of Empathy

Key Words

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Emotional processing
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Treatment

Abstract

Impairments of social behavior after cerebral damage are often problematic and difficult to assess and manage, with few models addressing evaluation, treatment options and prognosis. Recent studies suggest that a fundamental mechanism of social behavior disturbed by acquired cerebral damage is empathy. Empathy refers to the cognitive and emotional processes that bind people together in various kinds of relationships that permit sharing of experiences as well as understanding of others. Empathic changes are particularly evident after focal prefrontal cortex damage and closed head injury in adults, though early frontal lobe damage is also associated with poor empathic and social development. Although alterations in empathy have been studied in only a handful of neurologic samples thus far, it may be an important outcome variable of brain injury, particularly in patients' adjustment to family, community and vocational settings. Treatment possibilities are presented, though more comprehensive research is needed.

Introduction

How one person relates to another is a fundamental building block for societies, families and all activities where people are brought together through occupation, education, recreational interests, and many other needs. Interest in social behavior and its many variations spans not only the formal behavioral and medical sciences but most domains that draw upon psychological inquiry and human experience, with perhaps as many insightful observations from poets as from scientists. The focus of this commentary, though, is on describing one aspect of complex social behavior, i.e., empathy, that has been referred to as a binding force among persons and only recently has begun to be investigated from a neuroscientific perspective. Understanding the neural basis of empathy and adaptive social behavior in general requires anal-

ysis beyond current constructs such as intelligence, memory, language and emotions to interactions of these processing streams with neurobiologic and environmental influences on prosocial activities. The importance of adaptive social behavior is being recognized more frequently in health and disease treatment as well, with patterns of human behavior becoming increasingly interdependent, and the interactions between neurobiologic functioning and environmental/social forces being identified more clearly.

Historical Points on Social Behavior and the Brain

Available information on the neural bases of social/interpersonal behavior can be found in niches of theories, models, case reports and diagnostic categories that are

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Paul J. Eslinger, PhD
Division of Neurology, Hershey Medical Center
PO Box 850, Hershey, PA 17033 (USA)
Tel. +1 717 531 8694, Fax +1 717 531 4694
E-Mail peslinge@med.hmc.pshs.edu

intriguing and useful. Yet, attempts at bridging the gaps among these approaches are rare. Some of the most revealing lessons about social behavior and the brain come from studies of patients with frontal lobe damage. Harlow's [1, 2] descriptions of the crowbar case, Phineas Gage, might be identified as a starting point for scientific consideration of these issues [see 3 and 4 for more recent comments on this case]. Many other clinical investigators contributed in the years that followed including Jastrowitz, Welt and Oppenheim [see 5 for a comprehensive review] and the notion of a *frontal lobe syndrome* characterized by disturbed social behavior and emotional processing not accounted for by intellectual change, aphasia or amnesia became established. Analyses were subsequently expanded to: (1) soldiers with missile injuries to the brain [6–8]; (2) emerging neurosurgical treatments for patients with tumors, epilepsy and other diseases involving the frontal and temporal lobes, including the era of psychosurgery [9–12]; (3) animal models of frontal-temporal brain injuries [13–17] and more recent neurophysiologic recording studies [18–21], and (4) to experimental neuropsychological studies and theoretical formulations concerning discrete frontal lobe lesions and specific neural networks related to cognitive, social and emotional processing [22–27].

In descriptive and experimental analysis of cases with acquired cerebral damage, the aforementioned studies have been consistent: disruptions to prefrontal regions cause profound disturbances in how people relate to others, though in diverse ways. The animal model studies have confirmed this important relationship and even extended it to the interconnecting anterior temporal lobe as well (particularly involving limbic system structures of the amygdala and temporal polar cortex [15, 16]). Not surprisingly, this decisive and regulatory role appears to be as crucial during social development as it is during adulthood [28–30]. In these conclusions, few would likely differ, but consensus provides little understanding of how and why profound social impairments occur, and what forms of interventions and treatment are possible.

Empathy and Social Behavior

One approach to the neurobehavioral study of social behavior is to identify and investigate fundamental processes such as the emotional, cognitive, and physiologic elements that subservise a broad range of adaptive social behaviors. The construct of empathy appears to contain many such elements. Historical definitions of empathy

have underscored its emotional aspects; that is, a sharing of emotional experiences and states with others [31, 32], possibly reflecting how emotionally sensitive and responsive a person is to the emotional experiences of others. This is a process vital to many types of relationships and can be described as emotionally based or affective empathy.

More contemporary accounts, though, have elaborated other aspects of empathy, including a predominantly cognitive component (i.e., the 'understanding' of another's experiences and emotional states, dependent upon cognitive processes). Theories of social behavior have emphasized *role-taking* and *perspective-taking* as cognitive processes critical to understanding others, relating to others and fostering a sense of community among individuals [33, 34]. Developmentally, the ability to perceive and think beyond our own needs, goals and desires, to include those of others is necessary for the emergence of mental models, schemas and other forms of working knowledge (some described as 'theory of mind' processes) about others and ourselves in relationship to others (i.e., social cognition). Neuropsychologically, the notions of role-taking and perspective-taking require a dimension of cognitive flexibility such as being able to generate and consider ideas and different response possibilities as well as incorporating changing information into decision-making, choice of behavioral responses and understanding of others. Within a social cognition framework therefore, role-taking, perspective-taking and cognitive flexibility would appear to be as fundamental to empathy as emotional sensitivity and responsiveness. The available measures of empathy have followed similar lines, with emphasis on psychometric approaches that probe both affective and cognitive aspects of relating to and understanding others with reliable and valid self-report and rating inventories.

Effects of Cerebral Damage on Empathy

Empathy and its diverse elements, however, have not been investigated very much in neurologic populations. When we applied measures of cognitive flexibility and an empathic behavior rating scale to samples of neurologic patients, we discovered several relationships.

In previously normal adult patients with diverse etiologies and locations of acquired cerebral lesions, the mean empathy score was significantly lower than the normal comparison group. Specifically, 56% of the neurologic sample generated empathy scores greater than 2 standard deviations below the normative mean. Interestingly, the

results were similar whether patients rated themselves or family members rated patients on the standardized scale. Furthermore, significant correlations in the 0.5–0.6 range were found between cognitive flexibility measures and empathy scores. These correlations were in the directions expected, with an *inverse relationship* between empathy scores and impaired parameters of cognitive flexibility such as perseverative errors on the Wisconsin Card Sorting task, and a *positive relationship* between verbal associative fluency score and empathy score. These data supported the idea that flexible thinking may be related in an important way to empathic behaviors, possibly as a prerequisite cognitive skill or as part of a common underlying process [35]. Furthermore, the robust findings raised the concern that alterations in empathy were frequent after brain injury, and may need to be considered in models of neurorehabilitation and neuropsychological adjustment.

Different Effects of Frontal Lobe Lesions

The above findings led us to consider the hypothesis that empathic processing may be especially impaired after frontal lobe lesions, given the profound social and emotional processing difficulties these patients can exhibit [36]. Curiously, when adult patients with acquired focal lesions of the frontal lobe were compared to those with posterior (nonfrontal) lesions, the overall group empathy scores did not differ. Both groups, though, were significantly lower than normal controls.

Interestingly, the empathy scores appeared to be lowered for different reasons: the nonfrontal lesion group endorsed items suggesting low social self-confidence, while the frontal lesion group endorsed items suggesting greater preference for conformity and situations that were routine, predictable and structured.

When the frontal lesion group was divided into subgroups with dorsolateral, mesial or orbital locations of damage, other informative relationships emerged, as summarized in table 1.

These results indicated contrasting patterns of how cognitive flexibility related to empathy scores after different locations of frontal damage. Strong correlations between empathy and cognitive flexibility measures were most evident for the left dorsolateral frontal lesion subjects (and to a lesser extent in right dorsolateral frontal lesion subjects who were also impaired in both sets of measures). In these groups, it is possible that cognitive impairments limited abilities to perceive, understand and interact adaptively with others. A different pattern, how-

Table 1. Correlations between cognitive flexibility measures and empathy scores in patients with select lesions of the frontal lobe

Frontal lesion location	Cognitive flexibility	Empathy	Correlation
Left dorsolateral	impaired	impaired	0.76–0.81*
Right dorsolateral	impaired	impaired	0.29–0.38
Mesial	impaired	normal	0.18–0.41
Orbital	normal	impaired	0.23–0.36

* $p < 0.05$.

ever, was evident for the orbitofrontal lesion subjects, perhaps best known for their prominent social impairments and lowest in their empathy scores among all groups. The orbitofrontal lesion subjects did not sustain the cognitive flexibility changes that might lead to impaired thinking about others and themselves in relationship to others. In fact, we often find such patients to describe social matters fairly accurately but not to guide their behavior accordingly. Therefore, alternative explanations for their impairment need to be entertained. Possibilities include changes in autonomic processing that might be important for social and personal decision making and behavioral regulation [37], and impairment in modifying previously learned associations that come to acquire different consequences (e.g., reversal learning and extinction) [38]. The mesial frontal lesion subjects were also unrelated on the cognitive flexibility and empathy variables, being impaired in cognitive measures but not reporting a significant change in empathic processes.

Two other observations with frontal lesion patients were noteworthy. First, their self-report ratings of empathy in the early phase after frontal lesion (within 1 month of onset) showed only modest reduction. However, report of empathic change increased to a significant reduction at the 6-month follow-up evaluation [39]. This contrasted with the pattern of family member reports which detected significant reductions in both the early and later recovery phases. It appeared likely that ancillary deficits in self-monitoring and self-awareness of these patients might account for this delayed effect. Also, the accumulating results of any negative social experiences in the test-retest interval might provide some basis for increasing awareness of difficulties in some patients, regardless of whether their behavior actually changed. The findings have implications for treatment planning, as discussed later. Secondly, frontal lesion patients who maintained normal

empathy scores experienced a more positive social and vocational outcome than patients with reduced empathy scores [40]. Although these findings require validation with larger samples, evaluation of empathy in frontal damaged patients may prove to be beneficial for treatment planning and long-term management.

Closed Head Injury in Early and Later Recovery Stages

In a sample of moderate closed head injured (CHI) subjects, studied in the early recovery phase and again 6 months later, a marked alteration in their empathy scores occurred [39, 41]. Similar to the focal frontal lesion cases, family members rated the patients as quite different even in the early recovery phase, but CHI subjects rated themselves as normal. In the 6-month follow-up phase, patients' ratings dropped significantly, catching up with family member ratings of change. This may have been related to resolution of postconcussive effects interfering with memory, awareness and insight, together with experiencing the results of social impairments from concussive effects on frontal-temporal neural systems and even more diffuse axonal injury. Whether such social changes are related to specific frontal-temporal disruption or to cumulative effects of diffuse axonal injury on neural networks is presently unclear, but given the similarity of the behavioral pattern to the focal frontal lesion cases, a frontal lobe hypothesis can be entertained.

Developmental Effects of Early Frontal Lesions

We have obtained data on the social development of 2 cases with early frontal damage. The first, D.T., sustained left polar and mesial frontal lesion from intraparenchymal hemorrhage at 7 years of age and was studied as an adult at 33 years of age. Her empathy and cognitive flexibility scores were both greater than 2 standard deviations below the normative mean [42]. Her developmental history has been fraught with the consequences of these impairments which have markedly limited her ability to engage in stable, positive relationships within her family and within her community. In addition, her vocational progress has been erratic because of demanding and insensitive behavior, portraying little understanding of others and how to interact cooperatively. Interestingly, these difficulties were not immediately evident after her early frontal lesion, and did not emerge until early adoles-

cence (about 3–5 years after her lesion). This delayed temporal course may have been influenced by frontal maturational delays or deficits that did not surface until the marked escalation of social complexity that adolescence and adulthood introduces.

The second case, M.J., suffered a right dorsolateral prefrontal cortex lesion at 3 years of age and is currently entering college [30]. He has been studied since 8 years of age. While he continues to show increasing range of general adaptation, this young man's empathic behaviors have remained minimal, whether gauged by psychometric instruments or social experiences. Furthermore, poor empathy has been the most prominent feature of his social developmental difficulties. For example, his socially inappropriate remarks and inability to perceive or reason about the emotional states of others suggest a gap in the empathic aspects of social cognition. This extends to understanding the emotional intentions of others as well, e.g., why they might like or dislike him, why they may call on him or thoughtlessly stand him up. While he can formulate reasons for such interpersonal actions (e.g., they were unable to make it on time etc.), he shows little reflection on such emotional experiences. Interestingly, cognitive flexibility scores have been normal. He relates well to family pets and has adapted more effectively within large, impersonal group settings (public high school) than smaller, personal settings (individual friends, family, private school).

Interrelationship between Cognitive and Emotional Empathy after Brain Injury

The multidimensional nature of empathy was probed in a neuropsychological study which included ratings of *both* cognitive and emotional empathy [43]. Specifically, we were interested in determining whether changes in these 2 aspects of empathy would be similarly affected after acquired cerebral injuries, or whether dissociations and diverse forms of empathic change might occur. Therefore, 37 adults ranging in age from 23 to 70 years were studied. Etiology was kept diverse for sampling purposes and included closed head injury (n = 24), ischemic hemispheric stroke (n = 5), encephalitis (n = 1), clipping of ruptured aneurysm (n = 5) and multiple sclerosis (n = 2). Mean time postonset was 2 years. Measures included the Hogan Empathy scale [44], which provides a strong indication of role-taking and perspective-taking ability as the more *cognitive* form of empathy, and the Questionnaire Method of Emotional Empathy [45] which delves into

how susceptible individuals are to the emotional distress of another and their emotional responsiveness to others' experiences, as the more *emotional* form of empathy.

Analysis of empathy scores indicated significant lowering in comparison to normative observations ($p < 0.01$) for both cognitive and emotional empathy scales. This result was the same whether the patients themselves completed the rating scales or whether family members provided ratings. While these alterations were reflected predominantly in a loss of empathic behaviors after cerebral damage, a small percentage of patients (5%) exhibited empathic disinhibition or a heightened susceptibility to other's situations and emotional states, sometimes causing more symptoms of anxiety. Furthermore, correlational analysis of the two different empathy scores indicated no significant statistical relationship between them (0.176, $p = 0.29$, accounting for only 5.4% of the variance). Ratings by family members showed a slightly higher correlation (0.36, $p = 0.051$) which accounted for 13.4% of the variance. Although both empathy scales detected change, the lack of correlation suggested the two types of empathy may be mediated by different functional-anatomic systems and that patients may be afflicted disproportionately by more cognitive or emotional empathic change. When one considers these results with the pattern of findings discussed above on the effects of different frontal lobe lesions, it raises the hypothesis of whether there might be anatomic-functional correlation between *dorsolateral* frontal systems and predominantly *cognitive* aspects of empathic processing and *orbitofrontal* systems and *emotional* empathic processing. This has not yet been directly tested scientifically, but the available case material strongly supports this possibility.

Possible Therapeutic Interventions

Treatment of alterations in empathic processing and behavior is not clearly established. In our experience, it is unlikely that an insight-oriented approach will prove helpful for most patients since the very processes of abstraction, self-monitoring and self-evaluation that underlie development of insight are often significantly affected by the cerebral injury and indeed part of the basis for the empathic change. However, other approaches to increasing prosocial behavior are possible. We divide these into three areas: individual behavioral and cognitive interventions, music therapy and social support groups, and family interventions.

Individual Behavioral and Cognitive Interventions

Both behavioral and cognitive approaches to increasing empathic responses in patients may be possible. If the cognitive impairments prevent insight-oriented work because of loss of abstraction, self-monitoring or language, the primary focus can be on identifying and reinforcing those behaviors which are important for a particular patient's relationships. Intervention can include behavior modification procedures with pragmatic communication skills and reformulating conversational information to include others' viewpoints more frequently. This has been our focus with one particularly impaired patient, whose extensive polar and orbitofrontal lesion prevents insight and cognitively oriented work at empathic change. A complementary case has involved a 49-year-old college-educated accountant who suffered a right middle cerebral artery stroke with involvement of the frontal deep white matter pathways, particularly those interconnecting orbitofrontal and anterior temporal lobe, similar to previous cases we described with poor social and vocational outcome after frontal lobe lesion producing significant reduction of empathy [40]. Rather than loss of insight, abstract cognitive processing, self-regulatory or self-monitoring skills, this gentleman simply experienced few if any emotional states after his stroke. He no longer felt the need to engage in meaningful emotional relationships with his spouse and children, became critical of them and was no longer motivated to abide by the emotional dynamics that has been longstanding in these relationships. However, with a cognitive-oriented approach, he came to clearly understand these issues and began to intentionally become 'more responsive' on a behavioral basis, realizing its importance for the lives of others. Despite the notable improvement reported by family members, he nonetheless continued to report few if any emotional states.

Music Therapy and Social Support Groups

Clinicians have long been interested in developing and implementing methods that foster positive affective change. One experimental approach we recently implemented utilized music therapy and social support group formats to influence empathic processes in a chronic brain injured sample [Stouffer et al., unpubl. data]. For many persons, recreational music plays a vital role in soothing emotional states, influencing motivation and concentration, and providing a dynamic medium for creativity and expression that does not depend upon words and rules of propositional speech. Thaut [46] has argued persuasively that music therapy provides an efficient method of evoking affective states and generating positive

emotional responses that can be facilitated, supported and joined with cognitive interventions to produce therapeutic change within a structured group format. Another group format involves semistructured social support, which centers around sharing of personal experiences from a common illness, traumatic experience or set of maladaptive habits. Various themes are generally introduced in order to stimulate problem-solving activities and ideas.

We were particularly interested in chronic brain-injured subjects, with diverse etiologies predominantly of traumatic brain injury and cerebrovascular disease, where formal and informal rehabilitation services had been completed. Empirical measures of cognitive empathy, emotional empathy, depression, cognitive capacity and social behavior were collected on these subjects in a pre- and posttesting design. Participants met twice a week for 10 weeks in an improvisational music therapy group or a social support group. The results showed statistically significant improvement in emotional empathy for both groups, although the improvements were reported by the family members for the music therapy participants and by participants themselves in the social support group. Measure of depression improved slightly in the music therapy group, and the support group reported improvement in their daily competencies. It is likely that music therapy and social support interventions have different types of effects that underlie these changes. Possibly, future studies will combine such activities in creative ways, even incorporating more recreational activities with animals (e.g., dogs, cats, horseback riding) and spontaneous social activities (e.g., dinner outings, theater) that entail combined emotional and cognitive processing in a regulated manner. At this point in time, such interventions can be considered to have potentially beneficial effects for social and emotional processing impairments, including empathic alterations after cerebral damage.

Family Therapy

In matters of emotional processing and interpersonal relationships after cerebral injury, the involvement of families is perhaps the critical variable in long-term management and outcome. A productive approach in such cases is to involve the family very early in the rehabilitation process through education about brain injury, its effects on behavior and the often disruptive effects on family relationships, roles and dynamics. This is necessarily a multistep process, as the unfolding of social/emotional effects of brain injury and interventions for the adjustment reactions may require many months. When cogni-

tive impairments of patients are significant, with loss of insight, self-monitoring, and self-regulatory skills, families must be supported to develop behavior management skills, altered decision-making rules, and very different expectations for their roles and the role of the patient within the family. Work-related issues can be similarly complex, with the patient often viewing return to work as the benchmark of recovery. The influence of neurologist and neuropsychologist is especially important at these times, for providing objective evaluation of progress, new resources for treatment, setting guidelines on risky activities such as driving and operating machinery, and detecting depression and other emotional/adjustment difficulties that require treatment. An experienced neuropsychologist can often provide effective therapeutic services for sorting out and addressing issues of cognitive impairment, emotional difficulties, altered family dynamics and roles, and adjustment reactions on the part of patient and family.

Conclusion

The data and observations available on neurologic and neuropsychologic systems that mediate empathic processing and behaviors are only beginning to emerge. From the studies reviewed, it is proposed that the prefrontal cortex is particularly vital to empathic processing and regulation of empathic behaviors. The dorsolateral frontal region and its diverse networks may be more specialized for cognitively-based empathy or the interpersonal understanding that emerges from role-taking, perspective-taking and the flexible analysis of other's points of view, experiences and states. The orbitofrontal region and its diverse networks may be more specialized for emotional aspects of empathy, which entails emotional responsiveness and sensitivity to the emotional states and experiences of others. Both are critical to social adaptation and success, though in varying proportions depending upon the nature of the interpersonal relationship. Hence, injuries to these neural systems, whether from cerebrovascular, traumatic, or other diseases of the frontal lobes, can be expected to affect empathic processing and behavior in a large number of patients who may not realize and begin compensating for such changes for many months. Disturbances are reflected as a reduction in empathy in most cases, but a small percentage of patients may exhibit release or disinhibition of empathic responses after cerebral damage. Several treatment possibilities are discussed including behavioral, cognitive, music therapy, support group and

family interventions. Interventions need to be tailored to a particular patient's presentation and needs, but the neurologist and neuropsychologist have important, complementary roles to play in diagnosis and management. Cross-talk among different clinicians, investigators and therapists is particularly important to further progress, as

is evaluation of the methods that can be brought to bear on issues of brain systems and prosocial behavior. Further studies are needed to systematically survey, monitor and study interrelationships of neurologic disease and social behavior/social adjustment outcome.

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