Social cognition and traumatic brain injury
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CHAPTER 7

Summary and general discussion
The chapters in this dissertation have been arranged around two major themes: the ecological validity of assessment and the effectiveness of treatment of deficits in social cognition after moderate to severe traumatic brain injury (TBI). First, the aim was to study the assessment of social cognition with ecologically valid measures with important everyday life relevance (chapter 2, 3, 4). Second, a multifaceted treatment for deficits in social cognition and emotion regulation (T-ScEmo) is developed and its significance for everyday functioning evaluated (chapter 5 and 6). In this final chapter, the main findings are described followed by methodological considerations, clinical implications, closing with some recommendations for future research.

**SUMMARY OF CHAPTERS AND MAIN FINDINGS**

In chapter 2 the reliability and validity of the shortened version of The Awareness of Social Inferences Test (TASIT-short) is examined. The TASIT-short assesses emotion recognition and social inferences in dynamic social interactions (film-vignettes). A hundred-and-fourteen participants have been included: 98 healthy controls and 16 patients with acquired brain injury. The TASIT-short appears sensitive to brain injury as it significantly differentiated between the healthy controls and the patients with acquired brain injury. Analyses confirms the ecological validity of TASIT-short.

In chapter 3 the relation between the recognition of fearful faces of others and risky decision making was evaluated. Recognition of fear on facial expressions is generally associated with the ability to experience fear using it as a warning signal to guide risky decision making. To investigate this, 49 patients with TBI and 59 healthy participants have been assessed with a test for emotion recognition test (Facial Expression of Emotion: Stimuli and Tests) as well as a gambling task (Iowa Gambling Task). Patients with TBI perform far less adequate on fear recognition and decision making in comparison to the healthy group. Further, in patients with TBI as well as in healthy participants, significant relationships have been found between better fear recognition followed by the choice of beneficial strategies across the decision making task, and less risky behavior. The results of this study indicate an obvious link between poor recognition of fearful faces, impaired decision making and a preference for risky behavior.

According to the results presented in chapter 4, measures for social cognition explains a large proportion of variance in two statistical prediction models for social and vocational participation in a TBI group \(n = 63\). The inclusion of social cognition predictors, in particular Theory of Mind, yielded additional explained variance which was significant over and beyond the amounts of variance explained by measures for executive functioning, dysexecutive behavior and age and injury severity. This is an important finding given that recognition of these deficits at an early stage may allow early treatment, thus preventing an unfavorable outcome, and making them important targets for rehabilitation.

Chapter 5 contains a detailed description of the multifaceted treatment protocol, including recommendations for clinical practice and future treatment opportunities.

In a randomized controlled trial (chapter 6), 59 outpatients with moderate to severe TBI and
Impairments in social cognition have been treated either with the newly developed multifaceted T-ScEmo protocol or control treatment, a computerized cognitive training aimed at improving general cognitive functioning. After treatment, the T-ScEmo group performed significantly better on several relevant measures compared to the control group, which is also reflected in larger effect sizes. On follow up the improvement pertained to measures for emotion recognition, perspective taking, empathy, societal participation, quality of life and quality of life partner relationships. This demonstrates that the use of the compensatory strategies that had been taught is preserved over time and that these strategies had been independently applied, without the continuing support of neuropsychologists. Also, the results have not been caused by retest-effects, Hawthorne effects, effects of practice or spontaneous recovery, since the experimental group outranked the control group. Hence, impairments in social cognition can be effectively dealt with by using the multifaceted treatment protocol.

ASSESSEMENT OF SOCIAL COGNITION

Test characteristics

Although deficits in social cognition after brain injury have received a lot of research attention lately, there still is a lot to be gained in the clinical field. Hence, the relevant topic at hand would be the use of social cognition tests in clinical practice. Recently, Kelly and colleagues (2017) have reported that neuropsychologists estimate the presence of deficits in social cognition following severe TBI to be high; nevertheless, the vast majority still trusts on clinical observations only instead of trying to objectify these deficits with tests. In the Netherlands, a number of social cognition tests are available. The ecological validity of these tests is largely unknown, yet it is crucial to establish to what extent performances in such tests are useful to predict everyday functioning. Chaytor and Schmitter-Edgecombe (2003) have described two approaches to define ecological validity in neuropsychological assessments: verisimilitude and veridicality. Verisimilitude refers to “the degree to which the cognitive demands of a test theoretically resemble the cognitive demands in the everyday environment”. Following this line of thought, a test with dynamic stimuli, such as The Awareness of Social Inferences (TASIT), would resemble real-life situations more appropriately than tests with static stimuli like the facial photographs of the Facial Ekman Expression Stimuli and Test (FEEST), and may therefore, have higher ecological validity. Veridicality is defined as “the degree to which existing tests are empirically related to measures of everyday functioning”. According to this notion, a test with static stimuli, such as the FEEST, can still be considered ecologically valid as long as a significant relation with behavioral impairments in everyday functioning has been demonstrated.

Association of social cognition tests with indices of everyday functioning

Within the context of this dissertation, we investigated the ecological validity of social cognition tests with both the veridicality and verisimilitude approach. The verisimilitude approach by evaluating a measure for social cognition that is closer to real-life social situations than the currently available
measures, since film-clips of social interactions have been used (chapter 2). Indeed, The TASIT-
short proves to be sensitive for detecting deficits in social cognition after brain injury. However, its reliability in reassessments and therefore sensitivity to detect change is questionable due to crossover effects, as mentioned in chapters 2 and 5. It is an inherent characteristic of tests using dynamic stimuli that a specific cognitive function in isolation can hardly be measured. Hence, it is unknown to what extent “background noises” of other cognitive dysfunctions may also be reflected in test performances. Film vignettes, with rapidly changing social information, for instance, also require swiftness of information procession and divided attention capacities. Consequently, a task that shows better similarities to daily life situations is not necessarily a better test for measuring a specific deficit.

Consistent with the verisimilitude approach, behavioral questionnaires by a self and a significant other have been included in order to observe behavior in the everyday environment. By comparing both perspectives we were able to examine impaired self-insight and objectify the behavioral problems of patients with TBI in everyday functioning.

The traditional FEEST with its static pictures\(^5\), appears sensitive to deficits in facial emotion recognition in patients with TBI (chapter 2, 4, 6), has been significantly related to work resumption (chapter 4) and the recognition of fearful faces has been associated significantly with risky decision making (chapter 3). Further, the FEEST remains sensitive across (re)assessments and appears to be a valid measure of treatment effect (chapter 6). However, the FEEST appears to be no significant predictor in the prediction models for social and vocational participation (chapter 4). Adequate emotion recognition is considered a prerequisite for the ability to form a ToM and understand the thoughts and feelings of others. According to chapter 4, however, it is even more important to adequately interpret these emotional signals and their meaning within a specific social context, that it is to have an intact ToM ability. The static tests for ToM are reported to be significant predictors in both statistical prediction models for participation (chapter 4) and one of them, the Cartoon Test, also measures a significant improvement after treatment (chapter 6).

So far, we have demonstrated in our studies that traditional static tests for social cognition prove to be: 1) sensitive for brain injury, 2) valid measures of treatment effect, 3) sufficiently associated with real-life behavioral problems, 4) valid predictors of participation (chapter 2, 3, 4 and 6), indicating that they are ecologically valid. Altogether this indicates that static tests (i.e., FEEST, Cartoons Test, Faux Pas Test) combined with a behavioral questionnaire (i.e., DEX) are strongly recommended to become part of neuropsychological assessments post-TBI, in order to make a more accurate and complete prediction of patient’s everyday functioning.

**CLINICAL IMPLICATIONS FOR TREATMENT**

*Multifaceted treatment*

The effects of the newly developed multifaceted treatment of social cognition and emotion regulation (T-ScEmo) have been evaluated in a randomized controlled trial (RCT, see Chapter 5
This is the first study evaluating the effects of a multifaceted treatment on social cognition in such a design, i.e. with effects on several aspects of both social cognition and everyday social functioning and participation.

The T-ScEmo protocol includes teaching patients compensatory strategies for deficits in social cognition combined with behavioral skills training (Chapter 5). The treatment ingredients have built upon and presumably strengthened each other. By offering some variety in treatment options the protocol successfully fits the heterogeneous patient population with its diversity of problems in social cognition (Chapter 5 and 6). Although this comprehensive treatment approach proves to be overall effective, it remains hardly possible to identify the specific effective ingredients of this approach. However, we are convinced that crucial elements of the treatment success pertain to: 1) starting out with an elaborate neuropsychological assessment to identify patients' strengths and weaknesses, 2) offering psycho-education to increase patients' insight and herewith encourage treatment motivation (chapter 2, 4, 5 and 6), 3) applying a multifaceted treatment approach targeting on a broad range of social cognition and behavioral aspects (chapter 5, 6), in addition to 4) participation of a significant other within the treatment to restore communication, offer ongoing feedback and counseled practice in shared everyday functioning (chapter 5, 6).

Insight and motivation
From the literature we know that patients with TBI tend to under-report behavioral problems. Given the discrepancies between self and significant other reports that we found, the reasoned conclusion would be that within this specific patient sample lack of insight or denial of problems are common (see chapter 4 and 6). Poor insight is considered an important hindrance to rehabilitation as well, given its negative impact on treatment adherence and apparent lack of motivation to change. Armed with this knowledge, attempts to improve insight and motivation for treatment were twofold. Each patient's lack of self-insight has been assessed by comparing the patients self-ratings to the reports on everyday behavioral problems by their significant others. Differences between both perspectives are addressed in the psycho-education session. As a rule, discussion within a treatment session between patients and their significant others about who is right is usually avoided, and both are invited to work together towards a higher quality relationship and improved functioning in general (see chapter 5). Further, active reflection on and correction of social behavior have been the key factors in increasing patients' insight (Chapter 5 and 6). Within role-playing, for instance, the consequences of insensitive behavior are addressed (i.e., hurting others) and socially appropriate behavior is practiced. Although not directly measured in the RCT, it was clinically noticed that patients became increasingly aware of the consequences of inappropriate behavior, making efforts preventing such behavior sometimes with the aid of an external signal and applied damage control (see case study, chapter 5). We deem it likely that all of these elements contributed to improved insight along with adhesion to treatment given the low dropout rates in the RCT (chapter 6).
**Challenges to social learning**

Providing patients with social skills treatment after moderate to severe TBI has been found challenging since the patients’ shortfalls in: 1) self-awareness, 2) motivation to change social behavior, 3) knowledge of social rules and roles, 4) self-regulation, and 5) capacity to transfer learned skills within the treatment context to real-life situations. Consequently, it is hard for patients to adapt well to a variety of social contexts without sufficient understanding and responsiveness to own and other's emotions and mental states, and besides these, without an active knowledge of specific situational rules.

In the T-ScEmo protocol, patients with poor social information processing had to learn strategies and behavioral skills within a social context. The neuropsychologist served as a role model to strengthen social learning and the learning from others. During the sessions, patient behavior has been carefully observed in order to correct inappropriate or antisocial utterances (see chapter 5). Further, information and strategies for social reciprocity (e.g., social rules, conventions) have been included to address patients’ lack of declarative and procedural knowledge. By way of role-playing social behavior was practiced in various contexts, and on various levels of complexity. To stimulate transfer to the real world patients received homework assignments. Based on literature, the training of significant others has been incorporated in the T-ScEmo protocol (chapter 5 and 6). Significant others stimulate communication about feelings, expectations and intentions, offering ongoing feedback and counseled practice in everyday life (chapter 5). To make social learning work, patients have to learn from the ‘right’ others. In future research, it will be interesting to determine a number of specific characteristics of these significant others and to evaluate their additional contribution to the effects of treatment.

**CLINICAL RECOMMENDATIONS**

*When to start assessment and treatment?*

Since most deficits in social cognition barely recover spontaneously over time, there should be a neuropsychological assessment within three months post-TBI. Hence, an early assessment offers the opportunity to identify any problems in time, and consequently start education of patients and their relatives about the problems. For an effective timing it is recommended to start treatment six months post-TBI at the earliest, when patients have resumed some of their activities and possibly have already had to face social difficulties in everyday functioning. It is very likely, however, that patients do not spontaneously develop a full awareness of their socio-behavioral problems as has been described in studies comparing reports of patients and significant others. It should be clear not to wait too long with treatment given the harmful consequences of social cognition impairments in work and relationships (chapter 4). Moreover, as has been noted earlier, treatment can further improve patients’ insight (chapter 5, 6).
Whom to offer T-ScEmo?

As mentioned in chapter 6, the T-ScEmo protocol is an effective method for patients with a moderate to severe TBI. In anticipation of treatment, information about patients’ learning capacity is necessary to maximize treatment effect. Some patients, for instance, need carefully prepared repetition assignments of strategies or additional compensatory memory aids. Undoubtedly, there are bound to be differences in treatment effect based on individual variance. In future research, it is considered important to apply regression analyses and identify the patient characteristics favorable to significant improvements in the T-ScEmo condition, such as age, intelligence, educational level or general cognition.

Furthermore, we deem it plausible for patients with deficits in social cognition due to types of acquired brain injury other than TBI, to profit from the multifaceted T-ScEmo protocol. Cipolotti and colleagues (2015), for instance, found no differences in frontal lesions and none in executive dysfunction across patient groups with different neurological etiologies (i.e., cerebrovascular accidents, low-grade brain tumor, high-grade brain tumor, meningitis). Similarly, in a study on emotion recognition no differences have been found between various neurological conditions. Different types of brain injury may obviously lead to identical social cognitive deficits. In the T-ScEmo pilot study that preceded the RCT, patients with various types of acquired brain damage had been included when deficits in social cognition had been registered. In this pilot study, the clinical experiences were comparable to patients with TBI. So far, the T-ScEmo protocol may be useful for other types of patients with acquired brain injury, provided that they have deficits in social cognition and associated behavioral problems. However, this can only be considered evidence based practice after thorough evaluation of the effectiveness in these particular patient groups.

Experiences of significant others

Ponsford and colleagues (2003) have described that changes in patients’ behavior following TBI also relate to increased emotional distress experienced by life partners and unhealthy family functioning. Over time, life partners reported increasing levels of burden, feelings of insufficiency, as well as fear or anger. As mentioned in chapter 6, life partners of patients in the T-ScEmo condition reported a higher relationship quality on follow-up, compared to life partners of control patients. One can speculate about the possible factors contributing to these ratings of increased relationship quality. Relevant factors are likely to include improved understanding of social cognitive consequences by life partners resulting in less conflicts, or patient’s overall improvements in social cognitive functioning. Further research is necessary to find the key factors (chapter 5 and 6).

Risk behavior

In agreement with our expectations, we found that poor fear perception and risky decision making are co-occurring phenomena (see Chapter 3). According to Blair’s Integrated Emotion System, amygdala dysfunction can impair the ability to detect others’ distress and thereby contribute to
inappropriate or antisocial behavior. Marsh and Blair (2008) reported in a meta-analysis that antisocial populations across twenty studies showed specific deficits in the recognition of fearful facial affect. Recently, Vermeij and colleagues (2018) have found that the connection between the amygdala and prefrontal cortex was disturbed in psychopaths with impulsive and antisocial characteristics. Thus, if individuals are not able to detect or feel the distress they are causing to another person, there is no signal to stop the behavior that is causing the harm. A pioneering study of Brooks and colleagues (1986) reports that after having sustained a severe TBI, patients’ use of threats or gestures of violence may increase dramatically over time. Although under-recognized, the rate of delinquents with a TBI is high and may vary between 31-83 percent worldwide. In a longitudinal study carried out by Elbogen and colleagues (2015), an increased risk of arrest following TBI is observed. Furthermore, a higher prevalence of TBI in men detained for burglary, sexual or violent offenses is reported, suggesting a possible relation between emotional and behavioral dysregulation and risky decision making. After T-ScEmo improved levels of empathy have been found, but its effects on aggression are yet unknown. Further investigation of the T-ScEmo protocol is of interest in order to analyze its potential protective long-term effects.

**DIRECTIONS FOR FUTURE RESEARCH**

**Assessment of treatment elements**

Future studies on a multifaceted social cognition treatment are recommended to investigating the effectivity of treatment elements. To understand emotion recognition and the treatment strategies improving this ability, analyzing emotion recognition skills before and after treatment with eye tracking methods may be fruitful. It is known from the literature that patients with amygdala lesions process eye information less effectively, therefore eye tracking data may provide a better understanding of the role of visual scanning in emotion recognition. An eye tracking scanning technique can specify the facial regions of interest (i.e. eyes, mouth, nose, and off regions). In this way it could be made clear whether patients have made lasting changes in detecting emotions after treatment, and could herewith be determined if these were the particular compensatory adaptations that have resulted in the improved emotion recognition.

**Treatment: some critical remarks**

As a result of our research, an evidence-based protocol for improving social cognition and emotion regulation now becomes available for patients with TBI. Nevertheless, therapy consisting of 16-20 individual treatment sessions seems to be quite long and expensive, for patients (i.e., time, transport) as well as health insurance companies. In future studies e-learning sessions may be made available for patients to practice and rehearse strategies at home, which will limit costs considerably. Future studies may incorporate additional e-learning sessions to reduce costs as patients will be able to practice or rehearse strategies at home. Inclusion of virtual reality treatment elements may further lessen the total amount of sessions and costs, by simulating social activities using virtual
feedback techniques. Nevertheless, it is recommended to keep the focus of the treatment on learning within the social context to allow for the transfer of newly learned behavioral skills to the everyday environment.

CONCLUSION
In research there is a growing interest in deficits in social cognition after moderate to severe TBI, yet the transfer to the clinical field has been limited so far. This dissertation attempts to bridge this cap. The tests for social cognition appeared sensitive for brain injury, correspond with everyday functioning, are associated with and are related to risky behavior predicting social and vocational participation. Moreover, the randomized controlled trial has resulted in an evidence-based treatment protocol for deficits in social cognition that should improve several aspects of social functioning in everyday life.

To conclude, the assessment and treatment of social cognition in patients with TBI is complex for its variety in determinants and the need for an individualized approach. Therefore, measuring and treating such challenging deficits in patients with a lack of insight and poor motivation requires a lot of effort. However, these efforts will turn out to be worthwhile when everyday functioning of patients with TBI actually improves.

References
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