COGNITIVE, EMOTIONAL AND BEHAVIOURAL CHANGES FOLLOWING TRAUMATIC BRAIN INJURY: MECHANISMS AND MANAGEMENT

INTRODUCTION

The current article presents an overview of rehabilitation following traumatic brain injury. It begins with a description of the types of brain damage which occur following head injury and the brain structures which are most often involved. The implication of damage to these structures is then discussed. Specified problems in cognitive abilities, emotional disturbance and social difficulties are described. A number of rehabilitation interventions are then described.

First, a case example of a behavioural program designed to contain a problem behaviour is discussed. Then, research demonstrating the specifics of social skills deficits is described and the potential of social skills retraining is discussed. A memory retraining package designed to facilitate educational reintegration is discussed and its effectiveness documented in a single case research design. The type of client who will not benefit from such an approach is also described and methods of identifying and rehabilitating such clients are discussed.

Finally, the generalization of the techniques described is addressed. An adolescent with a traumatic brain injury with frontal lobe damage and cognitive impairment upon neuropsychological assessment as well as deterioration of academic performance was dramatically assisted in returning to his premorbid level of aspirations through an intensive cognitive rehabilitation program.

TYPES OF NEUROPATHOLOGY IN HEAD INJURY

What are the most common forms of brain injury that you see in head injury? A number of brain structures will be mentioned in this section. These will be kept to a minimum for simplicity and the roles played by these structures will become apparent as the article progresses. Generally, key terms which may be unfamiliar to the lay person are italicized since these are critical to understanding head injury.

SHEARING AND STRETCHING OF BRAIN TISSUE

The first type of *neuropathology* or brain damage in head injury is the shearing, stretching, disconnection and general disruption of neural tissue (neurons or brain cells that are connected together) that is caused by the mechanical forces that are applied to the brain. This is particularly severe when the brain twists, swirls or rotates within the skull as occurs when rotational forces are applied to the head (i.e., the head turns on impact). Note that damage in this form is particularly severe in a few areas of the brain: the anterior tips of the frontal and temporal lobes, the corpus callosum and the pituitary hypothalamic connection which is involved in hormonal regulation.

CONTUSION (BRUISING)

A second neuropathological process common in head injury is contusion, or more simply, the bruising of brain tissue. This type of damage can occur under the site of the blow. Alternatively, because the brain is housed in a very rigid container, sudden deceleration or acceleration can cause the brain to impact and bruise itself against the interior of the skull. Often this causes a contusion in the area of the brain opposite the impact (contracoup). The interior of the skull has a number of bony ridges, protrusions and sharp edges. These pose a serious threat to the brain whenever you see rapid acceleration or deceleration. The area of the skull upon which the brain rests (i.e., the bottom half of the skull) has a number of these ridges. Thus, the undersurface of the brain, the frontal lobes and the temporal lobes are particularly susceptible to bruising. The anterior tips of the temporal lobes are also frequently involved.

INCREASED INTRACRANIAL PRESSURE

The third neuropathological process is the increase of pressure that occurs within the skull or cranium. Damage to any tissue will result in swelling or edema. In head injury this results in expansion of brain tissue where there is no room for expansion because of the fixed and rigid nature of the skull. As a result, as the brain expands it will actually herniate or cut itself against the sharp ridges described above. There will also be a reduction in blood flow because the increased pressure within the skull will cause constriction of the blood vessels to be constricted or reduced in size. These vessels will, therefore, not be able to carry as much blood, oxygen and nutrients to brain cells. Consequently, you may see actual ischemia or brain cell death. The structures of the brain most likely damaged by this process are the undersurface of the temporal lobes and the cingulate gyrus.

HAEMORRHAGE

The fourth type of neuropathology commonly seen is haemorrhaging (bleeding into the brain or around the brain). Just as neurons are stretched and sheared by mechanical forces, blood vessels are stretched, sheared and torn by these same forces. As a result there will be bleeding into the brain which will cause some cell death. Additionally, if there is enough bleeding, a large blood clot will develop—a haematoma. This will produce increased intracranial

pressure (see Increased Intracranial Pressure above) and compression of (pressure upon) the brain resulting in further brain cell loss. The areas most susceptible to this process include the corpus callosum, the undersurface of the frontal lobes and the anterior pole of the temporal lobes.

To summarize, then, the structures that are commonly involved in head injury include the frontal and temporal lobes, the cingulate gyrus, the corpus callosum and the pituitary hypothalamic connection.

THE IMPACT OF THE NEUROPATHOLOGY

The next question is, what effect does damage to these brain structures have upon cognition (thinking skills—intellect, memory, attention etc.), emotion and behaviour.

THE FRONTAL LOBES

The frontal lobes are involved in self-awareness. Following frontal lobe damage the individual is not as aware of their own needs or status. For example, they may neglect their own hygiene or need for nutrition. An inability to fully appreciate the extent of their own impairments and weaknesses is a common finding in head injured individuals. They might also be unable to appreciate how they and their behaviour impacts upon others.

Deficits in judgement and planning often arise following frontal lobe injuries. Thus, social errors may be committed because the individual is not able to foresee the consequences of their actions. They may fail to plan future actions appropriately.

Problems with inhibition (control of behaviour) may also arise. Disinhibition simply means that the individual is unable to refrain from engaging in certain behaviours that are suggested or elicited by the environment. It is as if an automobile's brakes are not working—the car can move freely but, once initiated, it is very difficult to stop it. Head injured individuals sometimes have great difficulty stopping such a behaviour on their own once they have initiated that behaviour. Furthermore, they may have great difficulty stopping themselves from engaging in a behaviour strongly suggested to them by stimuli in the environment. The inappropriateness of the behaviour has little impact and does not stop the behaviour. Thus, the problem behaviours occur.

Finally, cognitive rigidity is frequently seen—the individual has a great deal of difficulty thinking along new, different or creative lines. Other problems occasionally arise such as a lack of initiative and problems maintaining goal orientation for long periods. Difficulties with attention and concentration (distractibility) arise with frontal lobe injury and the individual may become apathetic. Emotional flattening or blunting and dulled emotional expressivity is also common. Deficient abstract thinking (the individual becomes overly concrete) may also be seen.

THE TEMPORAL LOBES

With damage to the temporal lobes, patients have severe difficulties retaining information. Memory is impaired. The temporal lobes also form a part of the limbic system—the emotional circuitry of the brain. It is involved in emotional feeling, understanding and output. Emotional controller regulation is also one of the roles played by this part of the brain. Without this ability emotions are sometimes expressed in extreme form with great intensity. The individual has great difficulty controlling emotions such as anger in modulated form. Range is sometimes seen in response to the slightest of provocations. This characteristic has been termed emotional flooding.

THE CINGULATE GYRUS

The cingulate gyrus is also a part of the emotional circuitry of the brain. With damage to this area, one also observes problems with the regulation of emotion. This area of the brain is also responsible for the orienting reflex, attending to a new stimulus. With damage to the cingulate gyrus habituation to or becoming used to a new stimulus does not occur, so that the stimulus remains new or deserving of attention or exploration. Thus, the individual remains easily distracted by even a constant stimulus in his/her environment.

THE CORPUS CALLOSUM

The corpus callosum is the fibre bundle that connects the two halves of the brain. Clients with corpus callosum damage often demonstrate emotional inconsistency. For example, one client spoke about her accident and about the death of a family member in that accident and yet she would be laughing and giggling as she spoke. There are some who believe that the right hemisphere is the emotional hemisphere. As such the corpus callosum damage may have promoted a disconnection between what she was saying and what she was feeling. Thus, inappropriate behaviour occurs in social situations, an inconsistency between emotion and verbal expression.

A new clinical concept I would like to introduce to you is alexithymia. This consists of difficulty identifying and describing the nature of one's own emotional being. Head injured individuals commonly have great difficulty talking about their emotions. Often their manner of thinking is extremely concrete, reality based (things rather than feelings) and detail oriented. Others, in interacting with them, may feel that the head injured individuals have an impoverished emotional life. Relationships may lack emotional intimacy. Difficulty identifying their own emotional feelings may also interfere with the psychotherapeutic process. It sometimes seems that topics of discussion lead to a road block or obstruction because of difficulties connecting these to emotions. The patient is unable to engage in the kind of emotional elaboration which is essential to the psychotherapeutic process. Such difficulties are sometimes encountered following corpus callosum damage.

In such a process, the implications for the individual's personal relationships, especially interpersonal intimacy, would be tremendous. Thus a major goal of our Social Skills Retraining Programme is to impart awareness of this deficit and foster compensatory strategies in order to enhance the quality of their social relationships and reduce the probability of social isolation.

THE PITUITARY HYPOTHALAMIC CONNECTION

The pituitary hypothalamic connection is also quite susceptible during traumatic brain injury. What function does it perform? Regulation of hormones. Damage to this can produce changes in emotional status or basic bodily functions which depend upon those hormones. For example, you may see depression or disturbances in basic life functions such as food intake, sexual functioning, etc. Eating disorders are not uncommon in individuals who have sustained injuries.

PSYCHOLOGICAL CHARACTERISTICS

I have described the cognitive, emotional and behavioural features that are a direct result of traumatic brain injury. These are the neurogenic features, those which are specifically caused by the brain injury. Now I will describe the factors that are the result of the person's psychological make-up. The most important factor here is the premorbid (before the accident) personality. At certain ages head injuries appear not to occur at random

throughout the population. Often, they tend to involve a specific type of individual. For obvious reasons this individual is often somebody who enjoys engaging in high risk activities. Those with such premorbid characteristics appear to be nonconforming, individualistic and somewhat rebellious. Often it appears that they had tendencies toward acting out premorbidly.

We also frequently see learning disabilities present before the accident. Many of these individuals never had a propensity for paper and pencil, scholastic, academic types of activities. Their successes in this area have been extremely limited. The result is great difficulty engaging them in rehabilitation activities with uncooperativeness, frustration, anger and irritability seen in response to rehabilitation activities.

Of course, we must discuss grieving here as well. The individual has lost many capacities and, consequently, emotions emerge such as anger, depression and self-blame. So many of these individuals feel that they are at fault: "Why was I so stupid? Why did I do that?" It is extremely difficult for them to tolerate these feelings.

This whole area is really compounded by their distance from their normal social network. Where do people go when they need support? They look to their social network, their family, their friends. These individuals are often separated from (i.e., in patients) or more distant from (i.e., in social isolation) those relatives and friends. The point here is that there are numerous psychological factors that interface with the process of rehabilitation.

COMMON BEHAVIOURAL MANIFESTATIONS OF TBI

Against this background of the structures involved and their role a number of behavioural manifestations are frequently seen following traumatic brain injury. These include uncooperativeness, in the form of resistive and oppositional behaviour, not only to rehabilitation activities but often to the guidelines, rules and regulations within an institution or clinic. Often this is strongly supported by denial of illness which has a devastating impact upon motivation for rehabilitation.

Two mechanisms need to be discussed regarding the denial of illness. The first is a direct result of the brain damage sustained. The patient is completely unaware of even something as blatant as a hemiparesis (paralysis). This is a syndrome called anosognosia which is defined as an inability to recognize one's own illness. This is often seen following right frontal damage (deficient self-awareness, as described above)

As the patient recovers from the anosognosia, typically, it does not remain an explicit or vocal denial of impairment. Rather, it evolves into an indifference to their impairments and weaknesses. They no longer vociferously deny their difficulties but, rather, just do not care about them—they do not matter. Consequently, they do not care to engage in rehabilitation regarding a deficit in which they have no interest.

The other mechanism in denial of illness is psychological. The individual wants to protect her/himself from the realization that they are now disabled so they choose to deny it. This is ego protective; they want to protect their image of themselves. Typically, you can work through this type of problem of accurate self-perception in psychotherapy, but it is extremely difficult, especially where there are problems with memory and the processing abstraction of verbal information. One must also be very cautious in discussing this issue because the patient may become emotionally overwhelmed if his self-protective denial is dismantled for an individual's defense mechanisms is critical.

As an example of denial, one individual who had sustained a head injury denied major memory problems. In trying to work the denial through a number of persons were pointing out a number of instances where he had forgotten something fairly important. His response was that everybody forgets to some degree. As another example, another

individual had problems with speech and language (aphasia). Initially, however, he denied them. Rather than engage in speech therapy in a rehabilitation setting, this individual expressed the determined view that he should go back home. His reasoning here was that he could not speak when he was born and he learned how to speak at home via his family. Therefore, he felt, he should return home rather than remain in hospital. Problems with reasoning are supporting the denial of the need for rehabilitation.

Another factor which impedes full emotional recognition of the disability is that some individuals lose the ability to recognize the emotional valence of situations. Situations that are upsetting to others do not affect these individuals emotionally. This precludes the development of potentially energizing emotions such as anger and sadness.

Other behavioural problems following traumatic brain injury include acting out and testing of limits. Verbal disinhibition is also frequently seen in this population. Physical aggression, disinhibited sexual behaviour, bizarre behaviour and withdrawal in amotivational states are also seen following head injury, although these tend to be less frequent. A number of patients demonstrate anorexia or weight loss as a result of insufficient caloric intake.

AN EXAMPLE OF A BEHAVIOURAL PROGRAM

The following case illustrates the utility of the behavioural analysis and taking the behavioural approach. This particular patient had sustained a severe head injury but also had a long history of alcohol abuse. As a result of striking out at others he had been transferred from nursing home to an inpatient psychiatric setting. The striking out behaviour that happened in the community was not very dangerous (because this was a very weak individual) but the community generally has little tolerance for this kind of behaviour. A behavioural analysis was done over a two week period where we looked at the antecedents (what triggered a behaviour), behaviours and consequences (what happened immediately after the behaviour) of this patient's striking out behaviour. This observation yielded four major points. First, this aggression typically occurred only between the hours of 8 p.m. and 7 a.m.—it happened at night. This man had a reduced level of consciousness due to his brain injury. He was less aware of his environment. At night, it seemed, this deteriorated further due to two factors. First, he became drowsy and second, the lights were dimmed, the number of cues which were available to him for orientation and awareness. Thus, he was more susceptible to being startled.

Second, the target behaviour occurred most frequently in his bedroom. Investigation here revealed that his bed had been pushed against the left wall of his bedroom. Thus, when people approached him, they did so from his left visual field (if he was lying on his back). He had a left homonymous hemianopia, meaning he was not aware of (could not see) visual stimuli approaching from his left side. Thus, it was likely that he had been startled by sudden noises and perhaps even touching when he had not seen others approaching and this may have prompted self-protective aggression.

The third point discerned was that when the target behaviour occurred outside the bedroom, it often occurred when he was approached from the left side. Again, he was being startled.

Finally, the nursing staff had decided to withhold his next cigarette following an aggressive episode in an effort to discourage this behaviour. He normally received one cigarette every two hours. Thus, he often did not receive his consequence for an hour or two after an aggressive behaviour. Immediate consequences are critical to behavioural management. The behavioural program which I recommended and which was subsequently implemented consisted of the following measures which correspond to each of the four points I have just described.

First, whenever staff approached the patient, between 9 p.m. and 7 a.m. they were asked to stimulate the patient first by turning on the lights, calling the patient's name, reassuring the patient and then obtaining verbal acknowledgment of their presence and purpose before moving within arm's length or striking distance of the patient.

Second, the patient's bed was pushed against the right hand wall, so that when staff approached the patient while he was in bed, they would do so from his intact right visual field. Third, in other situations, staff were also asked to approach him from his right side.

Fourth, a conditioned reinforcer was associated with the removal of cigarettes. That is, a red bandanna was wrapped (loosely) around his right knee. He received cigarettes as usual whenever this red bandanna was on. When it was not, however, he did not receive cigarettes. The red bandanna came to represent the removal of access to cigarettes and the consequence now immediately followed the problem behaviour. Whenever he struck out, the bandanna was immediately removed.

The implementation of these procedures resulted in a reduction in the frequency of occurrence of striking out behaviours. We were not, however able to eliminate aggression entirely.

SOCIAL SKILLS FOLLOWING HEAD INJURY

DESCRIPTION OF THE LITERATURE

Impairment of social and familial relationships is a common sequelae of traumatic brain injury. Thompson (1974) documented that lack of social contact was the primary concern of individuals who has sustained a traumatic brain injury one to six years after injury. Most of the individuals followed had lost contact with old friends and had failed to establish a new social network. Oddy (1984) also found social isolation to be frequent in a sample of individuals who had sustained a traumatic brain injury. Social isolation was significantly correlated with measures of confusion (forgetfulness and disorientation) and verbal expansiveness (tendency towards brashness outspokenness and verbal aggression). Memory deficits were also significantly correlated with the loss of social contact. Erlich and Sypps (1985) identified a number of deficits in pragmatic communication in the traumatic brain injury population. These included a reduced ability to repair incorrect messages, a lack of cohesion in narrative production, intermittent and difficulties maintaining topic.

Lezak (1980) described the marked disruption of familial relationships and the stages of familial adaptation to a family member who has sustained a traumatic brain injury. Oddy (1984) also documented marked familial frictions. Klonoff and Costa (1984) found that relatives of traumatic brain injury patients scored these patients as significantly more belligerent, socially withdrawn, negative, suspicious, helpless and confused. These studies confirm the clinical observation that traumatic brain injury results in chronic social skills deficits.

A STUDY OF SOCIAL SKILLS IN TRAUMATIC BRAIN INJURY

We conducted a study which is in preparation for publication (Cancelliere, Canty, Zevy & Reid, in prep.) to explore social skills in traumatic brain injury clients. Seven consecutive outpatients of an adolescent Head Injury Program participated in the study (all had loss of consciousness greater than 72 hours). The control group consisted of seven non head injured subjects. The primary assessment device in the current study was Simulated Social Interaction Test (Curran, 1982). This consists of a number of role playing social exercises which are videotaped. The most relevant section here if the final role playing situation which consisted of a five minute conversation with the

confederate. The subject was instructed that he/she was to start the conversation and confederates were given specific information around how to respond in order that they not monopolize or take the initiative in the conversation.

An abbreviation of the Social Performance Survey Schedule (Lowe & Cautela, 1978), a rating scale assessing 53 positive and negative social behaviours, was also utilized. It was completed by a family member or a close friend of each participant.

FINDINGS OF THE STUDY

Nine different component social skills were rated (by independent observers based on the video-tapes) in the Open Conversation situation. These scales ranged from very low/poor (1) to very high/good (5). The traumatic brain injury group was rated as poorer than the Control group in their eye contact, inflection and enthusiasm in voice, body movement and gesture to complement speech, relaxation and ease of initiating and maintaining conversation. Ratings made by a relative or close friend on the abbreviated Social Performance Survey Schedule showed that the traumatic brain injury group was rated as significantly worse on this schedule than the control group.

CONCLUSIONS OF STUDY

The current study demonstrated that severe head injuries are associated with chronic impairments in social skills. Social skills procedures should be used in rehabilitation and address (among other things) nonverbal social skills such as eye contact, prosody (tone, volume and speed of speech), and relaxation. Our Social Skills Training package has demonstrated good success in this area.

MEMORY RETRAINING TO SUPPORT EDUCATIONAL REINTEGRATION

Memory disorders are among the most common sequelae of traumatic brain injury due to the vulnerability of the temporal lobes. Memory is obviously critical to functional adaptation. Memory dysfunction is disruptive to vocational and especially educational functioning and is associated with disruption of social integration. A number of investigators have explored the usefulness of memory retraining with generally positive findings.

A STUDY OF THE EFFECTIVENESS OF MEMORY RETRAINING

A study which we recently published in the Archives of Physical Medicine and Rehabilitation (Cancelliere, Moncada & Reid, 1990) explored utility in two traumatically brain injured clients who were attempting to reintegrate scholastically. There was a focus upon the retraining of memory for verbal passages since this most closely resembles the type of information presented in the educational setting.

CERTAIN CLIENTS WILL IMPROVE WITH MEMORY RETRAINING

A similar procedure was implemented with another subject who had a severe memory impairment. This subject was essentially unable to retain the strategies taught in the memory retraining sessions. Accordingly, there was no treatment-related improvement observed in this patient.

CONCLUSIONS

This study indicated that memory retraining can be effective with a specific subset of traumatically brain-injured individuals. Neuropsychological assessment can be utilized to differentiate between those clients who will and will not benefit from this form of memory retraining.

PROCEDURAL LEARNING

Where a client will not benefit from this type of memory retraining, procedural retraining should be implemented. This consists of specialized techniques utilized to train motor procedures or algorithms (i.e., step-by-step methods) which are very specifically and rigidly available only for one particular situation. Thus, such individuals can be trained for undertaking a single specific task within a vocational setting.

THE ISSUE OF GENERALIZATION

INTRODUCTION

I would like to discuss a single case which I believe demonstrates the potential for generalization of cognitive rehabilitation techniques to the real environment.

CLIENT DESCRIPTION

This particular patient was 13 years old when involved in a motor vehicle accident. She suffered a brief loss of consciousness and a period of post-traumatic amnesia which persisted for six days. A CT scan was performed and revealed a left frontal contusion. Neuropsychological assessment approximately one year after injury revealed deficits in attention and concentration, psychomotor speed, arithmetic abilities, verbal abstract thinking, problem solving, mental flexibility, organizational abilities and sequencing. All of these capacities have been identified as frontal lobe functions and, therefore, would be susceptible to frontal lobe injury.

PREMORBID EDUCATIONAL ATTAINMENT

Prior to the head injury, the patient was in an advanced stream with generally above average grades.

POST-ACCIDENT ADJUSTMENT

Following the head injury all grades dropped into the below average range with some very marginal (i.e., 50) performances. During the next year and because of the deterioration in her performance the patient gradually dropped into the general stream where, despite the reduced academic expectations, she continued to earn below average grades.

COGNITIVE REHABILITATION

Approximately two years after her injury, we were asked to perform cognitive rehabilitation to facilitate educational reintegration. The cognitive rehabilitation program consisted of attention and concentration retraining through computerized exercises as well as training in the selective attending to of segments of information using a

visual and auditory highlighting procedure. Mock exams were staged to enhance decision making around the use of time as well as organizational procedures. A self-checking technique was introduced with special emphasis on visual vigilance. Paper and pencil exercises were assigned which permitted training on abstract thinking, problem solving, mental flexibility and taking the role to the other. All of these exercises were adapted around the actual scholastic material undertaken by the student so that there was actual exposure to and learning of academic materials within the cognitive rehabilitation sessions.

THE RESULTS

After working with the client through one semester there was a consequent marked improvement in grades. Furthermore, we know that our intervention was responsible for the improvement because the client was not motivated to attend rehabilitation. Consequently, at the beginning of each subsequent term the client refused to attend rehabilitation. However, academic difficulties followed quickly and the client then felt compelled to attend cognitive rehabilitation and following re-initiating of the program academic performance improved. Furthermore, the patient had never attained such grades since her head injury. That marked improvement has generally been maintained and the patient was able to access College. This patient has since completed the first year of College with impressive results. The point here is without such intervention this patient may not have completed high school let alone access college. She certainly would not have completed the first year of College without such cognitive rehabilitation. A number of premorbid indicators, however, predicted that if she had not received the head injury she would have attended at least College and perhaps University.

CHOOSING A REHABILITATION SERVICE

Familiarity with the operations of specific providers of rehabilitation is critical to choosing a rehabilitation service. Since the recent introduction of no-fault auto insurance (OMPP) with its $500,000 purchases of rehabilitation limit there has been a proliferation of rehabilitation service providers. In evaluating the best and most efficacious providers of such services the following variables should be evaluated:

Ask for and examine the qualifications (e.g., resumes) of the individuals employed in that particular service.

If you are a service provider become involved with a rehabilitation provider on a very gradual basis. More specifically, refer a couple of cases and observe the responsivity, flexibility, client satisfaction, client gains, the specifics of any programming design and the general consistency of programming available. This should not be evaluated simply on the basis of whether or not the client makes gains. There are clients that do not respond to rehabilitation irrespective of the quality of the process instituted by the rehabilitation service providers.

Do the rehabilitation providers have published or unpublished research available demonstrating the utility of their procedures. Do they have single case descriptions illustrating a typical approach.

User groups such as the Ontario Brain Injury Association are compiling lists of the availability of such services. In the future they expect to collect information on user satisfaction.

Has the service been available in the community for a substantial duration of time and does it have a good reputation with other service providers and users of service providers and users of services.

CONCLUSIONS

Traumatic brain injury can have a pervasive impact upon an individual with marked alteration of cognitive abilities, emotional status and personality and behaviour. The causes of these changes are typically found in the brain damage sustained although premorbid characteristics may be contributing. Competent rehabilitation and treatment can facilitate adaptation and adjustment.

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