Closed head injury

INTRODUCTION

Impairments in memory for people’s names have been reported in the elderly, patients with Alzheimer’s disease and anomic patients with various etiologies. The main topic of this thesis is the memory for people’s names in patients who have suffered a severe closed head injury. There is anecdotal evidence, mainly based on subjective reports, that memory for names is one of the most severely affected cognitive functions following closed head injury, but there is very little evidence from formal assessments.

This chapter gives a brief overview of the main characteristics and the most prominent cognitive consequences of closed head injury. The cognitive impairments which are especially relevant to the investigation of memory for people’s names are described in some detail and include impairments in verbal memory, mental speed and language. This overview will be rather concise because closed head injury and its consequences have already been described at length by several authors. The reader who would like to learn more about this subject can, for example, consult Brooks (1984), Levin, Grafman and Eisenberg (1987), Richardson (1990) or Van Zomeren and Saan (1990).

CHARACTERISTICS OF CLOSED HEAD INJURY

Definition

At first glance “closed head injury” suggests an injury to the head in which the skull is left intact, in contrast to “open head injury” in which parts of the skull are fractured and the brain is exposed. However, with regard to the clinical and neuropsychological consequences of head injury a distinction based on the primary cause of the damage appears more illuminating (Richardson, 1990). Closed head injury could then be defined as “an injury to the head in which the primary mechanism of damage is one of blunt impact” (Richardson, 1990, p. 3). In other words, damage to the brain follows from the head hitting or being hit by a blunt object, e.g. the steering wheel or the tarmac. Closed head injuries are distinguished from penetrating head injuries where the head is hit by a sharp object, such as a bullet or a knife, which penetrates the skull. Common neurological consequences of penetrating head injuries are focal brain lesions and little or no loss of consciousness. Closed head injuries, on the other hand, usually result in diffuse brain damage and loss of consciousness (Richardson, 1990). In this thesis, I will use Richardson’s definition of closed head injury and all the patients seen for this work had suffered a closed head injury according to this definition.
Immediate consequences of closed head injury

In closed head injuries, consciousness is typically lost immediately following the moment of impact. The level and duration of unconsciousness are important indicators of the severity of the brain damage. While the patient is still in coma, the depth of the coma can be monitored with the Glasgow Coma Scale (Teasdale & Jennett, 1974). When closed head injured patients regain consciousness they are usually disoriented in time and place and are unable to form new memories. This temporary state is called the post-traumatic amnesia (PTA), after the severe anterograde amnesia that occurs during this period. In general, the duration of the coma is included in the length of the PTA, which spans the interval between the moment of injury and the moment that the patient is fully orientated again and has regained his or her continuous day-to-day memory (Brooks, 1972).

The length of the PTA is regarded as a useful indicator of the severity of the damage and has proved a relatively good predictor of recovery. In the acute stage, when patients are out of coma, the duration of the PTA is determined by testing the patients’ orientation and day-to-day memory, either by a short interview or with standardized questionnaires, e.g. the Galveston Orientation and Amnesia Test (Crovitz, 1987). When patients are out of PTA and fully orientated, the length of the PTA can be estimated retrospectively from the patients’ subjective reports about the time immediately following the injury. Typically, patients have hardly any memories of the time they were in PTA and will usually say they were unconscious for the whole duration of that period (Richardson, 1990). A rough classification of severity of head injury is between a PTA length of less than 24 hours - mild closed head injury - and of more than 24 hours - severe head injury. More refined classifications have been proposed, for example by Russell (1971):

- length of PTA less than one hour - mild closed head injury
- 1 to 24 hours - moderate
- 1 to 7 days - severe
- more than 7 days - very severe

In addition to anterograde amnesia, closed head injured patients usually suffer from retrograde amnesia when they have woken from coma. That is, they have no recollections of the accident itself or the time preceding the accident. The period of which the patient has no recollection may range from just a few minutes to several months before the accident. With recovery the extent of the retrograde amnesia gradually diminishes with the oldest memories becoming available first. However, in most patients memories of the accident itself and the events immediately preceding the accident remain permanently inaccessible (Richardson, 1990; Van Zomeren & Saan, 1990).

The primary damage to the brain in closed head injuries is caused by motion of the
brain within the skull and motion within the brain mass itself. Diffuse brain damage, mainly in the white matter, is produced by shearing strains within the brain caused by rotation of the brain relative to the skull. Diffuse damage may occur throughout the brain, but is usually more severe towards the surface of the brain than in the centre. If focal damage does occur, the most common locations are in the frontal or temporal lobes. Damage to the inferior parts of the frontal and temporal lobes is produced when the brain moves against the irregular bone structures at the base of the skull, the sphenoidal ridge. Focal damage can also occur under the site where the head was hit (coup) or diametrically opposite the site of impact (contre-coup). However, coup lesions often result from fractured skull bones which penetrate the underlying brain tissue (Richardson, 1990). Secondary brain damage can develop some time after the impact as a result of complications. Intracranial haematomas and brain swelling are among the most important complications (Richardson, 1990; Teasdale & Mendelow, 1984).

COGNITIVE IMPAIRMENTS FOLLOWING CLOSED HEAD INJURY

If patients survive the immediate damage caused by the impact and any subsequent complications, as most of them do, the outcome and recovery are very much dependent on the severity of the injury, but the extent of recovery varies for different functions. Among the physical functions motor impairment is a common residual disability, ranging from coordination problems to severe spasticity and pareses (Minderhoud & Van Zomeren, 1984; Richardson, 1990). However, recovery of physical functions tends to happen more quickly and to be more complete than recovery of psychological functions. This observation was first reported by Conkey in 1938 and has since then been confirmed by numerous studies (see Richardson, 1990).

The long-term consequences of severe closed head injury on psychological functions include changes in personality and social behaviour, and cognitive impairments. Changes in personality and social behaviour may be an emotional reaction to the injury and its consequences, but can also be a direct result of the brain damage, especially damage to the frontal and temporal lobes. Loss of insight into own functioning and disinhibition are common changes in personality (Bond, 1984; Van Zomeren & Saan, 1990). Impairments in cognitive functions are usually the most long lasting and disabling consequences of closed head injury. The residual cognitive impairments encountered most frequently are in the areas of memory and attention (Capruso & Levin, 1992; Van Zomeren & Saan, 1990).

Learning verbal and visual information

Recalling a person’s name involves an explicit response which requires access to the stored name information, and assumes that the stored information can be accessed upon demand.
In this respect, the name information is considered as declarative knowledge, that is, knowledge which is encoded and stored in a form that allows verbal report of its contents at will (Cohen, 1984). Declarative knowledge or declarative memory is contrasted with procedural knowledge or procedural memory the contents of which are not open to verbal report. Procedural memory is involved in learning perceptual-motor skills, while the verbal and visual learning tasks employed by most neuropsychological studies of memory are concerned with declarative memory. Unlike declarative memory, procedural memory is spared in most brain damaged patients, including head injured patients (Ewert, Levin, Watson & Kalsky, 1989; Wilson, Baddeley, Shiel & Patton, 1992).

The general pattern that emerges from the numerous studies which investigated memory performance in closed head injured patients, is that long-term, declarative, memory tends to be most severely impaired, while short-term memory is relatively spared (Baddeley, Harris, Sunderland, Watts & Wilson, 1987; Levin, 1989). Digit span is normal or near normal (Brooks, 1975; 1976; Brooks & Aughton, 1979; Dikmen, Temkin, McLean, Wyler & Machamer, 1987) and closed head injured patients display a normal recency effect on supra-span learning tasks (Brooks, 1975; Deelman & Saan, 1990). The impairment in long-term memory in closed head injured patients manifests itself in difficulties with learning new information since the time of the injury. Learning of verbal and visual information can both be impaired (Brooks, 1972; Sunderland, Harris & Baddeley, 1983). These impairments may persist many years following injury, and are often permanent in severely head injured patients (Tate, Fenelon, Manning, Hunter, 1991; Thomsen, 1984).

Most verbal memory tasks involve learning lists of words or word-pairs. Closed head injured patients typically recall fewer words on these tasks than neurologically intact control subjects (Baddeley, et al., 1987; Brooks, 1975; Geffen, Butterworth, Forrester & Geffen, 1994; Goldstein, Levin, Presley, Searcy, Colohan, Eisenberg, Jann & Bertolino-Kusnerik, 1994; Levin & Goldstein, 1986; Richardson, 1979). Some authors found this difference between patients and controls to be most pronounced after a 15 to 30-minute delay (Deelman, Brouwer, Van Zomeren & Saan, 1980; Sunderland et al., 1983). Very few studies looked at the learning of people’s names. Wilson (1987) showed that on a standard memory test, the Rivermead Behavioral Memory Test, learning a name to an unfamiliar face was one of the most difficult tasks for a group of memory impaired subjects, which consisted mainly of head injured patients. Berg (1993) also found impaired performance on a name-face learning task in a group of severely closed head injured patients.

Sunderland et al. (1983) reported impaired performance in a group of head injured patients on two visual memory tasks: Kimura’s Continuous Recognition test and a face recognition test. The latter result is interesting, because impaired face recognition may interfere with the patients’ ability to learn names to faces. Berg (1993) also found that head injured patients performed significantly less well than controls on Warrington’s face recognition test. Brooks (1974) and Goldstein et al. (1994) reported significantly lower overall
scores on the Continuous Recognition test in head injured patients relative to controls, while Levin, Goldstein, High and Eisenberg (1988), using the same recognition test, found no difference between patients and controls. This finding led Levin et al. (1988) to suggest that the verbal memory is more severely impaired in closed head injured patients than the visual memory. However, the comparability of the visual and verbal memory tasks is unclear. For example, verbal memory tasks usually require a free recall response, while most visual memory tests are recognition tasks. Consequently, the relatively intact visual memory of head injured patients, as reported by Levin et al. (1988) and by some earlier studies, could result from the different response requirements of the visual and the verbal memory tasks (Schacter and Crovitz, 1977).

The learning impairment in closed head injured patients has been related to reductions in the information processing capacity of these patients (Levin, 1989). For information to be stored into long-term, declarative memory it has to be processed or encoded (Cohen, 1984). As with other verbal information, encoding people’s names would require operations such as rehearsal or imagery. These operations are considered as effortful and would demand considerable amounts of information processing capacity (Hasher & Zacks, 1979). Effortful operations are contrasted with automatic operations which would demand minimal processing capacity, and are involved in encoding things such as the spatial location or the frequency of occurrence of stimuli. Automatic operations are relatively insensitive to variations in information processing capacity, while effortful operations are easily affected by reductions in processing capacity. The information processing capacity of severely closed head injured patients is usually reduced (Van Zomeren & Saan, 1990), and as a result the patients’ performance would be impaired on tasks which demand effortful operations, e.g. learning lists of words (Levin, 1989).

Difficulties in applying effortful operations may also underlie the passive approach to learning which is often observed in head injured patients (Levin, 1989). Suggestive of a passive learning approach was the lack of organisation seen in word-list recall. Levin and Goldstein (1986) noted that word-list recall in a group of head injured patients was marked by low levels of subjective organisation or clustering of words according to semantic category compared to controls. Poor clustering of list items according to semantic category was also found by Crosson, Novack, Trenerry and Craig (1988), and poor subjective organisation in word-list recall was previously reported by Deelman et al. (1980). Richardson (1979) suggested that verbal learning is impaired in head injured patients due to an inability to use mental imagery. This idea was based on Richardson’s (1979) findings that head injured patients recalled fewer concrete words than controls, while recall of abstract words was equal in the two groups. The patients’ failure to use imagery in verbal learning tasks could be considered as another example of a passive approach to learning.

Another possible explanation for the poor recall scores of head injured patients in learning tasks is an increase in the rate of forgetting and increased susceptibility to
interference in these patients (Levin, 1989). Stuss, Ely, Hugenholtz, Richard, LaRochelle & Bell (1985) found that head injured patients performed particularly poorly on the Brown-Peterson task, in which subjects perform an interfering task between consecutive recall trials. A similar detrimental effect of interference on word recall was reported by Geffen et al. (1994). However, Baddeley et al. (1987) found no indication of faster forgetting in head injured patients. In their study, the amount of forgetting over a one-week delay on a test of word recall and recognition and on a paired-associates task was equal for head injured patients and normal controls.

Retrieving information from semantic and remote memory

With regard to recognizing and naming familiar persons, intact recollection of events and encounters that took place during a person’s life time is important. Access to knowledge that was stored well before the onset of the brain damage appears preserved in most closed head injured patients. Retrieval from semantic memory is accurate in terms of the number of errors that patients make when asked for the meaning of words or sentences (Baddeley et al., 1987; Levin, 1989). Head injured patients are also able to benefit from semantic organization or semantic processing of word lists (Levin and Goldstein, 1986; Goldstein, Levin, Boake, Lohrey, 1990; Haut, Petros, Frank, Haut, 1991). However, the rate of access to semantic memory can be impaired following closed head injury. This is reflected by lower fluency scores and longer reaction times on category judgement tasks (Baddeley et al., 1987; Deelman & Saan, 1984; Haut et al., 1991). The reduced access rate to semantic memory may be an expression of the slowing in information processing in head injured patients. However, slow information processing can not fully account for the impaired fluency scores. Maring, Deelman & Brouwer (1986) found that head injured patients still performed worse than controls on fluency tasks without time constraints. Furthermore, the patients came up with fewer atypical exemplars from a semantic category than the controls. In Haut et al.’s (1991) study, the difference in response latencies between patients and controls was also larger for classifying atypical exemplars into a semantic category than for typical exemplars. There are some indications that the recollection of public or private events which took place many years ago is impaired in head injured patients (Baddeley et al., 1987; Crovitz, 1986; Levin, High, Meyers, von Laufen, Hayden & Eisenberg, 1985; Maring et al., 1986). However, little is known about the frequency with which these impairments occur following closed head injury (Baddeley et al., 1987).

Subjective reports of memory problems

Shortly after their injury, the subjective complaints of closed head injured patients are dominated by physical problems. However, as the time since injury increases complaints
about cognitive disabilities become more prominent (Dikmen, Machamer & Temkin, 1993; McKinlay, Brooks, Bond, Martinage & Marshall, 1981). Memory problems rank high among the cognitive difficulties reported by head injured patients. In fact, several years following injury poor memory functioning is the most frequently reported complaint. This is true for the patients themselves (Dikmen et al., 1993; Hinkeldey & Corrigan, 1990; Van Zomeren & Van den Burg, 1985) as well as for their relatives or caretakers (Brooks, Campsie, Symington, Beattie & McKinlay, 1986; Oddy, Coughlan, Tyerman & Jenkins, 1985; Thomsen, 1984).

Few studies distinguished between problems in different domains of memory. Sunderland et al. (1983) gave 65 severely head injured patients a questionnaire consisting of a list of 35 everyday memory failures. The patients and one of their relatives were asked to rate the frequency of each of these 35 errors in the patients’ daily life. Ranking highest in both the patients’ rating and the relatives’ rating were “forgetting where you have put something” and “finding that a word is on the tip of your tongue”, which were reported by more than 80% of the subjects. Unfortunately, Sunderland et al. (1983) provided only detailed information about the relatives’ ratings and did not report ratings concerning problems with learning of new information. Thomsen (1984) reported that 10 to 15 years following a severe head injury patients often have difficulties with remembering names, but it is not clear whether this remark was based on subjective reports or on test performance. Hinkeldey and Corrigan (1990) found that in a group of 55 severely head injured patients, interviewed one to five years post-injury, 60% complained of problems with remembering people’s names.

In an unpublished study, subjective memory reports were collected from 50 closed head injured patients several years post-injury. Apart from complaints regarding poor memory in general, problems in remembering people’s names were reported most frequently, namely by 58% of the patients (Koops, Deelman & Saan, 1981). Similar findings were reported in another unpublished study, with problems in remembering people’s names ranking highest among the memory complaints in a group of 38 severely closed head injured patients (Berg, 1993). Other authors have also noted that difficulties with people’s names are among the memory problems reported most frequently by closed head injured patients. The complaints concerned difficulties with retrieving the names of familiar persons (Brooks, 1984) as well as difficulties with learning the names of newly met persons (Wilson, 1984; 1987).

**Impairments in attention and mental speed**

The attention deficit is most pronounced in situations where closed head injured patients have to divide their attention between more than one task simultaneously (Van Zomeren & Brouwer, 1994; Van Zomeren & Saan, 1990). This impairment in divided attention is thought to arise from the mental slowness or reduced rate of information processing, which is a very common and persistent consequence of severe closed head injury (Ferraro, 1996; Spikman,
Van Zomeren & Deelman, 1996). The mental slowness can affect performance on all tasks that require mental operations under time-pressure, such as reaction time tasks (Van Zomeren, 1981; Van Zomeren & Deelman, 1978) or the Paced Auditory Serial Addition Task (Gronwall & Wrightson, 1981). In addition, the slowing of mental operations reduces the effective capacity of information processing, because fewer operations can be performed within the same amount of time (Van Zomeren, Brouwer & Deelman, 1984). That is why the deficit in divided attention could be a manifestation of the reduced information processing capacity. Other aspects of attention, such as focused or directed attention and sustained attention, appear intact following closed head injury (Spikman et al., 1996; Van Zomeren & Saan, 1990). The impairments in mental speed and attention are also reflected in the patients' subjective reports concerning mental inertia and the inability to do two things simultaneously (Hinkeldey & Corrigan, 1990; Oddy et al., 1985; Van Zomeren & Van den Burg, 1985).

Language impairments

Naming familiar persons is an act of language production and impairments in the language processes following closed head injury could, among other things, disrupt person naming. Language impairments have been found in head injured patients, and the impairment seen most frequently is anomia (Hartley & Levin, 1990; Van Zomeren & Saan, 1990). Anomia is marked by normal language comprehension and repetition, abnormal naming, and frequent use of paraphasias and circumlocutions (Heilman, Safran & Geschwind, 1971). Levin, Grossman and Kelly (1976) found impaired naming of familiar objects in 40% of the 50 patients they studied, who were out of PTA but still in hospital. Thomsen (1975) tested 50 severely head injured patients in the chronic stage and found naming impairments in about half of these patients. Goldstein et al. (1994) reported impaired picture naming in a group of patients who had sustained mild to moderate closed head injuries when they were over 50 years old. Kerr (1995) tested 20 severely head injured patients with the Boston Naming test and found that the patient group as a whole made significantly more errors than a group of matched control subjects. However, the distribution of the types of errors made by the two groups was very similar. In both groups semantic errors accounted for most of the naming errors. All these studies were restricted to naming of common objects, and none of the studies reported data concerning the naming of familiar persons.

Impairments in language comprehension are quite common shortly after injury. Levin et al. (1976) found impaired comprehension of complex verbal commands, such as required on the Token Test, in 32% of their patients. Comprehension of single words and phrases was intact in these patients. Six months following a severe closed head injury comprehension of complex commands, measured with the Token test, can still be impaired (Levin, Grossman, Rose & Teasdale, 1979). It should be noted, however, that poor
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performance on the Token Test can also result from memory impairments as subjects may be unable to remember the commands, e.g. “take all the rectangles, except the yellow one”. Thomsen (1975) found evidence for disturbed language comprehension in only one of 50 very severely head injured patients tested several years post-injury.

More subtle impairments in language expression have been observed in the spontaneous speech of closed head injured patients and are described as impairments in discourse (Hartley & Levin, 1990). The spontaneous speech of head injured patients can be inappropriate in length, confused, lacking informational content and slow. Language deficits may not be the sole cause for impairments in discourse. Normal discourse also requires adequate social and cognitive abilities, and these abilities are frequently impaired in closed head injured patients (Hartley & Levin, 1990; Van Zomeren & Saan, 1990). In general, the prospects for recovery of language functioning are rather good but residual deficits, especially in naming, may persist over many years (Hartley & Levin, 1990; Capruso & Levin, 1992).

Another disturbance which can disrupt speech production is dysarthria, although dysarthria is not considered a proper language disorder. Dysarthria refers to problems in speech production caused by disturbances in the motor control of the speech apparatus. Reported incidence of dysarthria in closed head injured patients ranged between 30% (Sarno, Buonaguro, Levita, 1986) and 89% (Najenson, Sazbon, Fiselzon, Becker, Schechter, 1978) of the patients tested in the acute or subacute stage. The high proportion reported by Najenson et al. (1978) is probably not representative, as it was based on no more than nine patients who had all suffered very severe head injuries. Little is known about the incidence of dysarthria several years post-injury.

Subjective reports of language problems in head injured patients are not as frequent as the reports of memory problems, and are often not among the most frequent complaints (Dikmen et al., 1993; Oddy et al., 1985; Van Zomeren & Van den Burg, 1985). However, in the study by Sunderland et al. (1983) more than 80% of the patients, seen two to eight years post-injury, reported word finding difficulties; words were on the tip of their tongue. Difficulties in language expression, including word finding problems, were reported by the relatives of 44% of the head injured patients seen 12 months post-injury (McKinlay et al., 1981) and by the relatives of 33% of the patients in a five-year follow-up by Brooks et al. (1986). Problems in speech production caused by dysarthria were also reported by some of the relatives (Brooks et al., 1986; McKinlay et al., 1981). Half of the relatives of the head injured group in Oddy et al.’s (1985) study reported difficulties with speaking. However, difficulties with speaking can refer to problems in linguistic expression as well as to dysarthria.

CONCLUSIONS AND FURTHER DIRECTIONS

The subjective reports of closed head injured patients concerning residual cognitive
problems often included problems in remembering people’s names. These reports could indicate that memory for people’s names in head injured patients is impaired as a result of the injury. However, studies reviewed in Chapter 1 showed that learning or retrieving a person’s name are relatively difficult tasks, even for normal subjects with an intact memory. Consequently, the problems with names reported by head injured patients may not be unusual and are not necessarily an indication of a deficit in their memory for people’s names. In order to conclude that memory for names is impaired following closed head injury, objective test scores need to supplement the subjective reports. Apart from a pilot-study reported by Wilson (1987) and unpublished data from Berg (1993), I am not familiar with published reports examining name learning or name retrieval in closed head injured patients by formal tests. Therefore, the first aim of this study is to determine whether the claims for an impaired memory for people’s names following closed head injury are justified.

As memory for people’s names will prove to be impaired in head injured patients, the next step will be to investigate the selectivity of the impairment and factors underlying or affecting the impairment. For example, Cohen (1990) showed that in normal subjects the meaningfulness of personal names has a clear effect on name recall. A relevant question would be whether the same effect can be found in head injured subjects. The naming impairment found in the patients with personal name anomia, described in Chapter 1, appeared to result from a disturbed access to the name lexicon. Are the problems with naming familiar persons in head injured patients also due to impaired lexical access or rather to disturbances at earlier stages? Investigation of these and other questions concerning memory for people’s names could provide more insight into the problems with people’s names found in closed head injured patients, and perhaps even in normal subjects. In addition, insight into the nature of the problems with names will be useful for the third aim of this study, namely to design and evaluate a training programme in an attempt to rehabilitate memory for people’s names in closed head injured patients.