

Chapter 1

Clinical neuropsychology: a historical outline

Introduction

- Around 400 BC, Hippocrates taught that all abnormal behaviours and emotions stemmed from the workings of the brain
 - he attempted (often unsuccessfully) to convince others that it was incorrect to attribute symptoms to extra-terrestrial forces such as the gods
- Rene Descartes (1596-1650): soul is an undivided, independent, yet immaterial entity
- Franz Joseph Gall (1758-1828): there are many mental organs located in the grey matter or cortex of the brain → lead to phrenology

Cell theory

- The mind was divided into different functions:
 - First cell: sensus communis: assumed to receive the information from the various senses
 - Second cell: believed to interpret the image (a psychological representation was called 'picture' or 'image', regardless of whether it was a visual or non-visual input)
 - Third cell: memoria: where the image was stored

Descartes: an undivided mind

- 'I think, therefore I am'
- Basic principle: people could be regarded as being composed of two substances, namely the body (the res extensa) and the mind (the res cogitans)
- Believed that the mind does not consist of material does not take up any space, but is located in a specific location → cavity in the middle of the head
- Mind = manager
- Throughout the body, messages about the outside world were received via the nerves, and messages were sent back using memories

Gall and the localisation issue

- He wanted to develop a new psychology based on his insights about the construction and function of the brain
 - Assumed that all psychological functions, be they knowledge, emotion, or a tendency to a certain behaviour, were innate
 - Each of these functions was concerned with an independent organ
 - The functions are located not somewhere in the middle of the brains but on the outside of the brain, in the cortex
- Most important proposition: primary function in the cerebral cortex are independent functions
- People vary in their aptitude for certain functions
 - Expressed differences in aptitude for these functions - one function is better, this means it is better organised and of a larger size
- Jean Pierre Flourens: it is not the location of a lesion but rather the degree of damage that determines which functions were affected

The clinic-anatomical method

- Jean-Baptiste Bouillaud: language should be located in the front part of the brain
- Method that was used to test the localisation ideas by charting the specific loss of function in patients with focal encephalopathy: Clinico-anatomical method
- Paul Broca: we speak using the left side of our brain
 - mechanism is present in the right side of the brain, but that the left side of the brain receives blood that is richer in oxygen, develops faster as a result, and is therefore the location of language
- Jean-Martin Charcot: believed in the localisation of specific centres in the brain
- Wernicke: there is a separate centre the recognition of word pictures → temporal lobe
- John Hughlings Jackson: Don't confuse the location of a lesion that resulted in a specific loss of function with the location of a function

Holism

- Kurt Goldstein: abstract attitude: sound functioning of the brain is of paramount importance in order to be able to reflect on incoming stimuli instead of simply reacting directly to them

- Following a brain lesion, person tends to react more directly to certain striking characteristics; they are driven by the stimulus
- Although the scientists who argued against localizationism warned (with good reason) of the dangers of oversimplification, they did not present a very convincing alternative
 - Even for holistics it was apparent that there was some degree of specialisation in the brain; it was clear to them that language was never located in the occipital lobe

Luria: a global model

- Aleksandr Romanovitsj Luria (1901-1977) attempted a synthesis of the neuro(psycho)logical facts and theories that existed at that time, and he integrated this with his own numerous clinical observations soldiers who had sustained brain injuries during world war 2
- Regarded the whole brain as a single complex functional system within which various subsystems contribute to joint activity
 - These functional subsystems arise as a result of interactions between the developing child and its environment, and they change during the child's development as a result of learning processes
- The functional system of the whole brain is extraordinarily flexible and adaptive
- Luria proved to be a fairly clear localizationist, as he was convinced that accurate scientific analysis of such behavioural disorder would always demonstrate a specific disruptive factor
- Three classifications for the functional architecture of the brain:
 - 3 continually interacting functional units, related to the subcortical, posterior, and anterior brain areas ('activation', 'input', and 'output', respectively)
 - to regulate alertness and attention; disorders here are caused in particular by injuries to the brainstem, the diencephalon, and the medial areas of the cerebrum
 - 3 hierarchically organised levels of processing, related to primary, secondary, and tertiary zones in the brain

- cognitive information processing - perception, processing, and storage of information; disorders here are caused by injuries behind the central fissure, in the posterior areas of the lateral cortex
 - Behaviour that is or is not regulated by language processes, related to left and right hemisphere, respectively
 - to organise behaviour - planning, regulation, and monitoring of goal-directed activities; disorders here occur in the case of injuries to the areas in front of the central fissure, namely motor, premotor, and prefrontal cortex
- Within each of these units a distinction can be drawn between primary, secondary, and tertiary zones, but Luria developed this theory for only the second and third units
- Primary zones: well-established projection areas of sense and locomotion, is, the modality-specific occipital (visual), temporal (auditory), and postcentral (sensory) areas in the second unit, and the precentral (motor) area in the third unit
 - Secondary zones: border on the primary zones and are largely modality specific, involved in the further processing of and assignation of meaning to the incoming information, and in the third unit they are implicated in the preparation of locomotion
 - Tertiary zones: the remaining areas, in particular the temporo-parieto-occipital junction and the prefrontal cortex

An initial impulse: the test battery

- In the USA, several psychologists had focused specifically on brain injuries - for example, Shepherd Ivory Franz and Ward Halstead
- Franz: focused on matters such as aphasia and localisation, but he was also working as a clinician at a hospital, where he was able to examine patients
- Halstead: conducted research into the effect of brain injury, in particular frontal lesions, on intelligence
- Halstead-Reitan Neuropsychological Battery: all tests together, intended to chart various psychological functions
- There is no conceptual basis for the battery - that is, there is no integral theory about the brain and behaviour underlying it
 - basically a screening tool can be used to briefly assess different aspects of cognitive functioning

- Luria-Nebraska Neuropsychological Battery: based on Luria's ideas and test procedures
- Using these tests, psychologists could study and describe cognitive functioning systematically, and were able to take over some of the work that until then had been carried out by neurologists

Neuropsychology as an independent discipline

- Around 1960, two major developments occurred in the USA that resulted the emergence of neuropsychology as a separate scientific discipline:
 - First development: the work of Norman Geschwind. He was influenced by Wernicke and wrote a major influential article about disconnections, and in doing so inspired many people to focus on the analysis of functions
 - Second development: the work of Roger Sperry into the effects of so-called split-brain surgery (with epilepsy patients)
 - It became clear that the right side of the brain was better at performing certain functions than the left side
 - A variety of research methods became available that could be used to conduct research into localisation of function in individuals who had not suffered any brain injury
- The rapid development of research into language disorders and difference between the hemispheres ensured that neuropsychology became a specialty in its own right

Cognitive neuropsychology

Modules

- Jerry Fodor (1983): language ability is an innate specific property, with syntax being of paramount importance. We have no awareness of these language processes, we do not have any control over them → This type of process is referred to as a module
- Distinction between representation (information that can be processed by a module or produced as output) and process (the calculation, computations, or transformations that are carried out on the representations)
- Marr (1982) formulated starting points for the construction of a theory about specific cognitive functions

- In the case of a cognitive function, information is converted from one specific type into a different type, for example, from sound to meaning. This can be seen as a translation operation
- Serial processing: the conversion of information to a subsequent level of representation

Neural networks

- Neural networks = actual neurons, but computer simulations - that is, computer software that simulates a certain cognitive function
- They were developed as systems that would work in the way as the brain, with each system consisting of a large collection of nodes (cells) that are connected together (by dendrites)
- Certain connections will be strengthened as a result of learning processes, so after some the input of a particular stimulus will result in an organised activity, which can in turn result in a particular response
- A neural network learns by trial and error → this kind of model can learn to read by practising, then reading is a property that occurs naturally
 - This is called “emergent property”
- Graceful degradation (another property): If this type of model is taught a certain function on a computer and then ‘damages’ several nodes, the whole function does not fail, but rather part of the required information is not taken into consideration
- Content addressability (another property): In neural networks, a small amount of the information can activate the whole memory trace, so inputting a few letters can activate the whole word
- A major problem for the networks is that they offer little insight into how the process actually works, and characteristics of stimuli are recorded and are available for possible reactions of a test subject

Neuroimaging

- Using computed tomography (CT) it was already possible to achieve better detection of injury to the brain tissue, but the possibilities increased significantly with the introduction of magnetic resonance imaging (MRI)

- Researchers could use electroencephalography (EEG), in particular the event-related potential (ERP) technique, to measure and record electrical activity that was linked to the perception of a stimulus characteristic
 - Using this technique, the functional properties of the brain can be studied, but not its anatomical structure
- One of the most recent developments is the recording and functional analysis not only of centres of activity, but also of the fibre tracts along which information travels between different centres
- An important effect of the many possibilities opened up by imaging was, that research started to focus increasingly on the neural correlates of cognitive processes
 - As a result, greater attention has been devoted to physiological processes in the brain, and to areas of the brain that are active during certain processes, and less attention has been given to theory development in the field of cognitive processes

Chapter 2

Neuropsychology in practice

Introduction

- Neuropsychologists are scientist-practitioners - they are clinicians with a knowledge of neuropsychological symptoms and test methods

Neuropsychological tests

Diagnostic cycle

- Neuropsychological assessment uses hypothesis testing
- Neuropsychologists run through a diagnostic cycle that consists of four stages: complaints analysis, problem analysis, diagnosis, and indication for treatment
- For each of these stages they formulate a hypothesis, which they test using data from the patient interview, observations, and neuropsychological tests and questionnaires

Referral question and definition of the problem

- A neuropsychological assessment always starts with a well-defined referral question
- ‘Are the cognitive disorders in line with Korsakoff’s syndrome?’

Interview with the patient

- An interview with the patient is important for collecting information about current complaints and symptoms and their progression
- An interview with the patient also provides an important initial impressions of the patient’s cognitive abilities and their behaviour, which is helpful for the selection of tests and questionnaires, and may contribute to the diagnosis
- If a patient denies having memory problems there may be a lack of awareness of their illness
- An interview with the patient is also a way of building a working relationship with the patient, which is very important given the painstaking assessment that follows

Interview with the informant

- Because of the nature of their disorder, many patients who are referred for a neuropsychological assessment are not necessarily able to provide reliable information about their complaints or their day-to-day functioning
- Information can be obtained from the patient’s partner, children and parents as well as, for example, from neighbours, friends, their gp, or previous carers
- An interview with the informant provides subjective information of course, and does not necessarily provide a true representation of the actual functioning of the patient

Observation

- Observations are recorded during the interview with the patient, the tests, and even outside the examination room
- It is important that these observations are as free from interpretation as possible
- Observations are especially important with regard to cognitive functioning

Tests and questionnaires

- They include screening tests, standardised test batteries, tests that focus on one cognitive function, behavioural neurological tests, self-assessment questionnaires, informant questionnaires, and observation scales

- The specific tests and questionnaires that the neuropsychologist chooses will depend on the referral question and the psychometric properties
- The essence of administering a test is that all patients have the same understanding of what is expected of them
 - A patient has to know what purpose of the task is and what they are being asked to do
- In addition to using tests, neuropsychologists often also utilise standardised questionnaires about personality traits, styles of coping, and mental complaints

Interpretation

- Interpretation involves the integration of all the data discussed above-the interview with the patient, the interview with the informant, the observations, and the test results
- Various considerations have to be addressed in order to assess whether a test result is abnormal:
 - The primary consideration is whether the test results are reliable, valid, and truly reflect the level of cognitive or emotional functioning of the patient who has been examined
- If the tests do not show any cognitive disorder, this does not necessarily mean that no brain injury or disorder is present
 - It may mean that the patient's cognitive functions are adequate under optimum conditions and that the complaints are possibly linked to environmental factors
- On the other hand, abnormal performances during tests do not always indicate persistent cognitive disorders, as they can also be a result of a temporary condition or of disruptive factors
- Differential diagnosis: When a diagnosis is made, a check should always be carried out to ascertain whether the complaints and problem might not also have another explanation

Reporting

- Reporting on the findings of neuropsychological assessment can be done verbally and in writing
- Written reports are initially drawn up for the referrer

- Verbal reports take place with the patient as well as in multidisciplinary meetings or in a meeting with the referrer
- According to most professional psychological standards, content of a psychological report must be discussed with the patient before the findings are reported to the referrer or discussed within a multidisciplinary team
- However, in situations where the diagnosis is not yet known and the neuropsychological assessment is part of a multidisciplinary process, it is not always a good idea to inform the patient of the conclusions of a neuropsychological examination

Reliability and validity

- Reliability and validity are important psychometric properties of a test - determine whether the test fulfils its purpose and whether the test result is a good reflection of the function to be measured

Reliability

- Test-retest reliability indicates the extent to which a test yields, the same results when it is taken at different times by the same patient
- It is also important for the reliability of a test that different researchers obtain comparable results under the same conditions

Validity

- Validity of a test consists of face validity, content validity, construct validity, criterion validity and ecological validity
 - Face validity: the extent to which a test initially seems to measure what it is supposed to measure
 - Content validity: the extent to which a test is representative of the topic that to be measured
 - Construct validity: the extent to which the result of a test actually reflects the cognitive function that is being assessed
 - Criterion validity: the extent to which a test can predict the performance of a patient with regard to an external criterion