Assessing Cognition: A Brief Overview of Neuropsychological Testing

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Timmy's teachers have noticed that he has struggled in school for the last few weeks. Timmy has always been studious and attentive, but recently he has forgotten to turn in assignments, and when he remembers, they are not completed with the accuracy he had shown just weeks ago. His teachers ask him if something has recently happened that would cause this sudden decline, and Timmy informs them that he has been feeling different since he was on the receiving end of a vicious tackle in a football game earlier that month. Understanding the general cause of the problem, Timmy's teachers send him to the school nurse who instructs him to see his primary care doctor. After an examination, his doctor refers him to a clinical neuropsychologist who will administer tests to assess whether or not Timmy is suffering from any cognitive deficits. Through testing, the neuropsychologists find that his memory and attention are comparatively worse than the average of someone of his demographic. Finally, Timmy's doctor is given these results, and creates a plan to help alleviate the physical and mental toll of his head injury through medication and rehabilitation. This is just one example of a situation in which neuropsychological testing is administered to help improve the quality of life of a patient. This book will provide more scenarios that would result in seeking neuropsychological testing, and it will detail some of the many types of tests that may be administered. Furthermore, the general process of what to expect when scheduling, taking, and interpreting these results will be discussed. While every specific scenario cannot be covered, this should serve as an introduction to the basics of neuropsych testing by exploring various examples that show the diverse capabilities of these assessments.

Introduction

Before diving into the process of neuropsychological tests, it is important to understand the responsibilities of a neuropsychologist and how they are specialized from other doctors and

psychologists. To give a broad definition, a neuropsychologist "studies the relationship between behavior and the brain" which allows them to "understand and diagnose behavioral, emotional, and cognitive changes" (UNC School of Medicine, 2021). With this understanding, the goal is to completely alleviate the problems or find and apply appropriate remedies. ("Neuropsychological Evaluation FAQ," 2021). "How To Become Neuropsychologist" (2020) summarizes the necessary education and preparation needed to practice this career. To have proper credentials, neuropsychologists will have a PhD. Because the field is rather obscure, there is not just one major that undergraduates hoping to be a licensed neuropsychologist can pursue. The most popular option is psychology, but biology, neuroscience, and pre-med majors will also have a sufficient educational background. There are two major subgroups of career paths to explore: research neuropsychology and clinical neuropsychology. In research, one may work for government agencies, private companies, or universities to develop new tests and teach aspiring students. If in the clinical field, one may work in schools, hospitals, nursing homes, or wherever there are people commonly susceptible to cognitive decline.

It may be surprising to realize that neuropsychologists are readily available in many places, as many people are still unaware that this specific career exists. Because of the lack of notoriety surrounding this job, it may appear to be a daunting task to find a specialist when a patient is looking to help themselves or a loved one. Luckily, most patients are given referrals through a professional, so as to take off the burden of searching for the correct doctor themselves. However, if one were interested in searching for a doctor by themselves, the American Academy of Clinical Neuropsychology provides a directory of specialists certified by the American Board of Clinical Neuropsychology (American Academy of Clinical Neuropsychology, 2018).

According to the book *Fractured Minds: A Case-Study Approach to Clinical Neuropsychology* (Ogden, 2005), referrals can come for many different reasons, with the most obvious being for people like Timmy searching for a medical diagnosis. Assessing disease progression/recovery, finding baseline cognitive abilities, and assessing mental capacity for legal cases are also reasons to see a neuropsychologist. For example, someone with frontal lobe damage may be charged with abusing their children with unusually harsh punishments. Frontal lobe damage can cause alterations in decision making, so it may be hard to determine if they were enacting abusive punishments out of cruelty or if it was just due to an altered brain that could not understand that their actions were wrong. A court could refer the accused parent to a neuropsychologist, who would administer tests to see if they have significant deficits in decision making, and the judge can decide whether or not this new evidence is of importance to the case. As a patient, finding the appropriate doctor is likely the responsibility of a healthcare professional and should not be an obstacle if one is desiring a test for valid reasons.

Procedure

Many patients who are referred to complete neuropsychological assessments are unfamiliar with the process, and may be reluctant to take these examinations out of nervousness and discomfort. To alleviate any of these fears, (Ogden, 2005) summarizes each step to fully explain what one may expect the day they are called in to do neuropsychological testing. The first step is getting a referral which will help connect the patient with an appropriate neuropsychologist and this has already been reviewed. Those administering the assessments also recognize that this procedure is out of the ordinary and prior to the test taking they will speak to the patients in a clinical interview. During this interview, they not only look to soothe any fears and answer the questions of the patients, but they also hope to gain further knowledge about the

patient's history and the problems they are experiencing. At this point, the only information that the neuropsychologist knows about the patient comes from what was written in the referral from the healthcare professional. By speaking directly to the patient and asking not only about the problems they are facing but also about their childhood, their medical history, their family life, and other general autobiographical information, provides additional context that should be taken into account when analyzing their test results. For instance, a woman may be referred to get tested due to a recent occurrence of memory loss. Her answers to the various questions inform the neuropsychologist that she has recently been promoted in her high-stress job and is working more hours than ever. The clinician knows that stress can affect memory, and will use this new information when reviewing her test results, and may recommend a different solution than if the background remained unknown. If possible, some family members and friends of the patient may be interviewed. Despite best efforts, patients may not be reliable with their personal information and family and friends are good resources who have more information than what is found on a medical chart. It should be noted that patients who are in an actively psychotic state or feel physically and mentally unwell will likely not be tested until these problems are treated. Testing is meant to assess patients at their best possible mental state, and if they are not, the full potential of their abilities may not be discovered.

The next step is the most obvious one: the assessment itself. This may be given by a technician training to be a neuropsychologist or the actual doctor. At an individual level, this whole experience will vary greatly depending on what specific tests are needed for each patient. The process however, should remain relatively constant. For most patients, one session of testing should last between two and five hours (UNC School of Medicine, 2021). These sessions may take up to eight hours over the course of two days if the assessed patient struggles with

attention and stamina. Ogden (2005) further explains that to ensure that the patients are performing at their highest potential, the environment in which they are in must be free of distractions. To accomplish this, the testing sites have good lighting, quiet settings, and windows that do not face backgrounds that could affect concentration. This is the standard for testing but may not always be true. Patients commonly see neuropsychologists to determine if they are fit to return to work or school after having some cognitive problem. In order to model a real work or school environment, these distractions may actually be necessary. An exact procedure will not fit the experiences of each patient, since the reasons for taking assessments vary so greatly. Later on, different types of assessments will be described with more detail, but for now the focus will be on the more general procedure.

Finally, once the actual tests are completed, a neuropsychologist will analyze the patient's results and write a report. In contrast to most visits to the doctor, it is possible that a patient may never actually see their exact results. Unless highly educated on the matter, the raw scores are not obviously comprehensible. To account for this, the neuropsychologist will create an uncomplicated and straightforward report that explains the results to whomever initially referred the patient. The final report will integrate what was learned in the initial interview with the raw data if applicable. The simplified information may then be shared with the patient. What happens next is completely dependent on the problems being faced, as the report may include recommendations for rehabilitation, follow-up consultations, diagnoses, or other important information (American Academy of Clinical Neuropsychology, 2018). This finishes the general procedure of neuropsychological testing, and although there are hundreds of different tests in existence, the tests exist within a few main categories including general intellect, language, visuospatial perception, executive functions, and memory. These, along with a couple more

specific tests will be detailed with specific examples regarding how the test works and why a patient may need it.

Intelligence

Being tested on intellectual ability may be a daunting task for some, but it is important for many reasons in neuropsychology. While tests of general intelligence can be used to assess the deficits of someone who has suffered from brain trauma, it is most widely used for children with developmental challenges. This is because a test for general intelligence does not expose specific problems -- there are other categories of neuropsychological tests for this that will be discussed later. The usual goal in clinical settings is to assess the patient's level of functioning, and how they may be expected to function in a social role. There are many different types of intelligence tests, but perhaps the most widely used is the Wechsler Adult Intelligence Scale (WAIS/WIS) (Ogden, 2005). Multiple iterations of this test have existed, but the current version is WAIS-IV, and is thoroughly explained by American Addiction Centers (2020). Within the WAIS-IV test, four different categories are scored to determine one's abilities in different areas of intelligence, and these categories are verbal comprehension, perceptual reasoning, working memory, and processing speed. In this example, the parents of a child with Down Syndrome want to assess the level of assistance their daughter Amy may need throughout her life.

First, Amy is tested on her verbal comprehension, with three subcategories (similarities, vocabulary, and information) and one supplementary test (comprehension) if needed. In the similarities subtest, Amy must identify how two objects or concepts are alike. As a child she may be asked to name how dogs and cats are the same, but if she were taking the test as an adult the questions may be a little more complex. This task tests her semantic knowledge (common factual knowledge) as well as her abstract verbal reasoning. Continuing with this verbal comprehension

subtest, Amy is tested on her vocabulary. Again, the words in which she is expected to properly comprehend are in accordance with her age, and her results will be compared to someone at a normal developmental level. The last required subtest in this category is a general, cultural information test that may ask about different presidents, countries, or famous events. Again, this may not apply to Amy when she is a child, but as she grows older and should be aware of this knowledge, then this task can be applied to test her cognitive functioning. Finally, if the neuropsychologist determines that more testing is needed to adequately understand how well Amy should be able to function in society, there is a supplemental comprehension test of social situations and abstract phrases. For example this could be whether or not Amy could understand common idioms without obvious meanings. These subtests will be given a verbal comprehension index score and Amy will continue by taking the other tests of different intellectual categories.

Next, Amy takes five subtests (three required and two supplementary) of the perceptual reasoning section of the WAIS-IV. One subtest is the block design test which looks to measure problem solving and visuospatial processing skills. In this task, Amy would be given some red and white blocks and try to construct the blocks in a way that corresponds to a given pattern. The quicker she is able to do this, the higher her score will be. The next required subtest is the matrix reasoning task, which measures nonverbal abstract problem solving. Amy will be presented with a visual pattern, with a piece of the pattern missing. From five possible options, she has to choose which image properly completes the pattern. The final required subtest of this section is the visual puzzles task, which tests nonverbal reasoning. Here, Amy will be presented with a puzzle and out of six options she must choose which pictures will construct the puzzle she was given. The two optional subtests are the picture completion and the figure weights tasks. In

the picture completion task Amy is tested on her ability to perceive visual details by being shown an incomplete picture -- a car without wheels for example. Consequently, she must identify that the wheels are missing, and her response to this and other similar images will be timed. Finally, the figure weights task will test Amy's quantitative reasoning. In this task, a scale with different quantities of certain shapes will be on each side, and using various combinations of these shapes, it is Amy's job to keep the scales balanced. The supplementary tasks may not always be used, but in order to obtain the most accurate data, some neuropsychologists will employ them.

Amy's working memory -- or short term memory -- is the next aspect of intelligence to be assessed. Memory has its own category of neuropsychological tests, but it is still included as an index of general intelligence. In the WAIS-IV, there are three working memory tasks, with one of the three being supplemental. The first task, the digit span, is a straightforward measurement of memory. The test administrator will say increasingly long sequences of numbers and Amy must repeat them back either in ascending or descending order, depending on the instructions. Next is the arithmetic task. Unlike the digit span, the difficulty of this task will be adjusted based on the age and background of the patient, as someone in high school should not be at the same mathematical skill level as someone in elementary school. Specifically, Amy has to complete 22 mental math problems, not only testing her memory but also her problem solving. The final and supplemental task is the letter-number sequencing task, which tests memory and attention skills. Similar to the digit span, the tester will say a sequence of numbers, but this time mixed with letters, and Amy will have to repeat them in alphabetic and numeric order (5GB29 becomes 259BG). As with all other indices of intelligence, Amy's scores will be compared to normative data to establish the severity of her deviation from average, if there is a deviation at all.

The final index in which intelligence is measured in the WAIS-IV is processing speed. Similar to the working memory index, there are two core tests and one supplementary. The first task, the symbol search, is a simple test that assesses Amy's processing speed. A target symbol is given to Amy who then has to point out if that target appears in various rows with many different symbols. To measure motor and mental speed, the last core test is employed, which is the coding task. For children like Amy, this task is picture based where a key associates certain pictures with corresponding symbols. From there, they will have to assign the correct symbol to the correct picture. In adults, the basis of this task is similar, but instead of pictures, letters and numbers are used. The final task in the WAIS-IV is the supplementary cancellation task. As simple as it sounds, patients are given a target symbol and proceed to mark off any instances of that symbol in a given group.

A combined score of each of these four indices calculates a full scale IQ score, whereas a combination of the verbal comprehension and perceptual reasoning scores calculates a General Ability Index. In Amy's case, the neuropsychologist analyzes the score in relation to typically developing children of her age to see how her cognitive functioning compares. It is characteristic of patients with Down Syndrome to have comparatively lower scores on many of these tests so it is not of concern if Amy's scores are below average. What will be important is identifying if Amy has any significant deficits in any of the tested aspects of intelligence, and to what extent these deficits will prevent her from living and functioning in an independent role in society. Again, Amy's case is simply an example, and the WAIS-IV and other intelligence tests can be used for a multitude of reasons. No matter the reasoning, the general construction of the WAIS-IV should be nearly identical to this case, so it serves as a sufficient overview of neuropsychological tests on general intellect.

Language

Similar to the intelligence tests, language tests are often long and expansive due to the many aspects that encompass it. Patients are most commonly referred for language examinations if they are suspected of suffering from some sort of aphasia, which refers to disorders that inhibit communication, either with regard to producing or comprehending language. Similar to intelligence tests, there are multiple different exams commonly used to assess the desired function, but since each is very comprehensive (and similar), only one will be examined -- the Boston Diagnostic Aphasia Evaluation (BDAE). As outlined by Figueiredo (2012) within the BDAE, there are eight subscales measuring different functions of language, each with multiple subtests. The goal of these subscales is to examine how people process and respond to language in different modalities. This time, a patient named Mary who suffered from a brain hemorrhage will serve as a prime example as a patient referred to a neuropsychologist for language assessments. Mary has undergone a few weeks of speech therapy and experiences the symptoms synonymous with Broca's Aphasia -- she can comprehend speech but has difficulty producing language of any kind. In order to gauge the scope of her deficits and ensure the specific type of aphasia she is facing, Mary completes the BDAE.

The first feature of language that is assessed is fluency. These tests are generally in a free narrative format, allowing the examiner to hear how patients speak in a regular, natural conversation. Because the structure of this subtest is supposed to be an open conversation, it would not be natural for the administrator to constantly pause to write notes about how the patient is performing, so usually this portion of the test is recorded and analyzed later. Here, the tester will engage Mary in a conversation (this could be a personal interview or a picture description) and there is a list of features of her speech that will be studied: melodic line, phase

length, articulatory agility, grammatical form, paraphasias, and word finding. The melodic line, phase length, and articulatory agility measurements are used to determine whether or not Mary's speech sounds natural and fluent. The conversations illustrate how Mary takes many pauses while talking, and her output of speech is reduced compared to those of average abilities. The grammatical form of her speech is also evaluated in regards to the level of variety and complexity of her sentences. Because her speech mostly consists of brief utterances, the grammatical structure of her speech is contained to the most simple way to get her meaning across. Another common feature of aphasias is the inclusion of paraphasias, which refers to the addition of extraneous syllables or words in speech production. This can change the sound (floor becomes ploor) or the meaning (floor becomes ceiling). Mary makes some phonemic paraphasias (associated with sound) which further reduces the fluency of her speech. The last feature analyzed in this section is word finding. The feeling of having a word on the tip of your tongue happens occasionally to those with normal cognitive abilities, but aphasias amplify this problem. It is possible that Mary has trouble recalling the correct word, especially because her manner of speech is so slow and fragmented. Each of these features are scored on a scale from one to seven, and will be accounted for in the overall score with the other subscales.

The next subscale in the BDAE is auditory comprehension, which has multiple subtests. Mary first takes the word discrimination subtest where there are six different categories of words -- objects, letters, colors, numbers, actions, and geometric forms -- that she must identify. A card with five words is placed in front of her, and she must point to the one that the tester requests. Because her comprehension is intact, she performs well on this task. Now, she is given the body-part identification assessment which is as simple as it sounds. The examiner calls out a body part that Mary has to point to, and this is an easy way to test if she understands verbal

speech. Additionally, she is tested to identify something on the left side of her body and something on the right side to ensure her understanding of body relative directions. Another straightforward subtest is the commands task. The examiner verbally states commands of varying steps and Mary must follow the instructions. These commands will not consist of anything very difficult, but it will test if her comprehension changes based on the complexity of the instructions (fold paper vs. fold paper and put on the floor). Concluding the auditory comprehension section is the test of complex ideational material. Mary is asked two yes/no questions -- one with each as the answer -- about very general knowledge. For example the 'yes' question could ask if a saw is good for cutting wood, whereas the 'no' question asks if a saw is good for pounding in nails. This entire section of tests is not difficult for Mary, as she only has problems with language production, not comprehension.

To test recall abilities, there is a set of subtests solely relating to naming. In the responsive naming task, Mary is verbally asked a question and she must come up with an accurate answer. Again, these questions are not difficult (Where do teachers work?) and should have one word answers. Although simplistic, it is enough to assess both comprehension and the ability to both recall a fact, and produce it. Breaking from what has been the norm for most tasks thus far, the visual confrontation subtest studies comprehension using visual rather than auditory stimuli. This is nearly identical to the word discrimination task described earlier, but instead of identifying the specific picture the tester asks for, Mary instead has to name every picture she sees on the cards. The last two features of this subscale are very clear. The animal naming task asks Mary to name every animal she can in a minute and the body part naming task asks her to identify body parts that the evaluator is pointing to. The point of these tasks is to see if Mary can easily recall both visual and auditory information and transfer this knowledge so it

can be vocally produced. Overall, she takes a long time to find the word she is looking for, but more times than not the word she is able to produce is accurate.

The oral reading subscale is brief, only containing two subtests: word reading and oral sentences. As suggested by their names, neither are particularly complex. For the first test, Mary is asked to read single words and for the second task she must read sentences. Given her prior results on the other tests from the BDAE, her word reading should be intact, and it is. Expectedly, her reading of sentences is much slower, with laborious articulation and a lack of fluency. However, Mary's weeks of therapy leading up to the test have helped her, and with time, she can vocalize all the words present in the sentences.

Another feature of language that is briefly studied is the production of automatic speech. This refers to sequences of words that would quickly and easily flow out of someone with normal language functions. For example, the automatized sequences task instructs Mary to recite a known series of words. This will be something as elementary as recounting the alphabet or the days of the week. In a slightly different subtest, Mary is prompted with another well known set of words -- the beginning of a nursery rhyme, for example -- and must complete the phrases. Again, Mary understands these tasks and can produce relatively accurate results, with the only difference being a lack of speed and fluency.

While Mary has already been tested on whether or not she can vocally read words and phrases, her reading comprehension has not been tested until this point. Various subtests in this section measure different aspects of reading comprehension. Starting at the most basic level, the symbol discrimination task determines whether or not Mary has retained the ability to recognize letters and words. For instance if she sees the letter 'G', she is asked to pick its equivalent out of the choices 'G2rTf', and if she sees the word 'pen', she is asked to pick its equivalent out of the

choices or ‘pen’, ‘pencil’, ‘pin’. Because Mary can do this, she shows the most fundamental knowledge of reading comprehension. In a slightly harder assignment, her understanding of words spelled verbally is reviewed. Just as it seems, the evaluator will say a word letter by letter (P-E-N) and Mary must realize that this word is the spelling of ‘pen’. Her grasp of language is still intact, so the only difficulty in this task would be physically producing the result, but since the expected output is a single word, she does not endure much of a struggle. Shifting from auditory to visual assessments, Mary does the word-picture matching task where she has choices of words and pictures, and must decide which are equivalent in meaning. This will help understand if her comprehension is constant across different modalities. Lastly, Mary has to read a paragraph and understand the words enough to complete sentences with plausible endings. The progression from single symbols to a full paragraph has enough range to reliably test Mary’s ability to understand what she is reading, and results indicate that her comprehension is relatively normal.

It should be of no surprise that after reading tests comes writing tests. In similar fashion, the exercises gradually increase in complexity. To test Mary’s writing mechanics, she is instructed to write both her name and her address. In comparison to her reading and speaking abilities, her writing is at a lower level. It is clear that she knows what she is supposed to write, but her letters look poorly formed, and she forgets a couple letters in her address. Another basic exercise has Mary writing the alphabet and the numbers 1-21. She is able to do so, but again the construction of letters and numbers are abnormal and worse than average. The next few tasks have Mary writing down letters, words, and sentences that she hears from the examiner and the outcome is similar to the first writing assignments. As she gets to writing sentences, she begins to omit more letters in her words, and others are just completely misspelled. Finally, Mary

completes the cookie theft task, which is arguably the most notable feature of the entire assessment. Despite this being classified as a writing subtest, it is also often used in the initial free narrative portion of the BDAE. Mary is presented with a wordless image that shows two kids taking something out of a container labeled 'cookie jar', while the adult in the room is doing the dishes and facing the other way. Depending on what is being tested, Mary has to describe what she believes is happening in the picture, either audibly or with writing. If she were to complete the task with spoken language, she would likely create an accurate narrative, but her recount will be filled with paraphasias and fragmented speech. If she were to write out what she sees, the same idea will present itself. Her writing should reflect that she comprehends the overall ideas, but her writing will be filled with misspellings, grammatical errors, and have a general sloppy nature. After her writing abilities are examined, only one major feature of language is left for reviewing.

Interestingly, one of the most crucial features used in determining the exact type of aphasia is whether or not the patient can repeat words or phrases. The repetition subscale tests both single word repetition and also the repetition of sentences. Like many other tasks, the word repetition assessment is administered in various levels of difficulty. Mary first repeats simple words, but the complexity gradually increases in syllable length, until she is finally instructed to repeat tongue twisters and long abstract verbs. In a turning point for her diagnosis, these subtests discover that Mary cannot repeat what the examiner is saying to her. This, along with her deficits in speech production and her ability to comprehend speech allow the doctors to narrow her disorder to transcortical motor aphasia, whose diagnosis matches this criteria. The BDAE may seem to be excessively comprehensive, but its completion time is usually between 90-120

minutes. With a more distinct diagnosis, Mary's speech therapy can be even more personalized, which should help her regain a normal level of language functioning more efficiently.

Memory

One of the most commonly depicted mental deficits in pop culture is memory impairments. Problems with memory are incredibly noticeable and have a large impact on those inflicted. However, in shows and movies, memory problems are often sensationalized and characters seem to completely forget everything about their lives and about the world. This can happen, but it does not represent the majority of memory impairments people experience -- in reality, people can struggle with certain aspects of memory, so neuropsychological tests need to be specific enough to identify the extent of the deficit. Interestingly working memory is tested in other categories of neuropsychological assessments. Looking back to the WAIS-IV testing general intelligence, an entire section is dedicated to working memory with tasks such as the digit span and the letter-number sequencing task. Looking forward to tests for visuospatial functioning, the Rey-Osterrieth Complex Figure test measures a more specific aspect of spatial working memory. For more comprehensive results, it is necessary to assess both short term and long term auditory and visual memory. This is what the Wechsler Memory Scale (WMS) -- which is currently in its fourth edition -- sets out to do. The WMS-IV is split between auditory, visual, and working memory and tests both immediate and delayed recall. In this example, Alex is a woman in her late sixties, whose daughter has noticed memory problems that have gotten progressively worse over the past few months. With these symptoms and the fact that Alex's dad suffered from dementia, her daughter asks her to see a doctor, who then refers her to a neuropsychologist for some tests to evaluate her memory. She will complete the WMS-IV as

well as a dementia-specific test called the Mini-Mental State Exam (MMSE) to see if her cognitive impairments are sufficient for a proper diagnosis.

The WMS-IV is composed of an auditory memory index, a visual memory index, and a working memory index, with the first two consisting of both immediate and delayed conditions. The contents of this test are explained by Maccow (2011). However, before any of the specific memory tests, Alex may be asked to take a general cognitive evaluation to understand her general capabilities. This may include drawing tests, speaking tests, and attention tests, but may vary depending on the patient. The reasoning for this general assessment is to get a sense of her baseline abilities, and if needed, certain tasks can be adjusted based on if her other cognitive functions are already limited.

In the auditory memory index, there are four main tasks for Alex to take: logical memory tests (I & II) and verbal paired associates tests (I & II). The main difference between the two versions of each test are if they test working memory or delayed memory. In the logical memory I subtest, the test administrator verbally tells Alex a short story. When the narrative is done, Alex must immediately recall its details without any prompts. Because she is an older woman who may be experiencing symptoms of dementia, the same story is told to her twice before she has to recite its details. In other cases with younger patients, two separate stories are told as opposed to the same one twice. Similarly in the logical memory II subtest, Alex must retell the story presented to her from the initial logical memory subtest after a time delay. First, she has to test her recall without any prompts or cues about the story. Following this is a test on the recognition (rather than recall) aspect of memory. Now, the administrator gives Alex yes or no questions regarding details from the story she heard and recited multiple times. The ability to recognize features from the story in contrast to actually retrieving the features from the brain are

different functions, so it is important to test them separately. In her assessment, Alex was able to accurately recall very few details in the story, but had more success when prompted with yes or no questions. The other part of the auditory memory index is the verbal paired associates subtest. In the verbal paired associates I subtest, the tester lists ten to fourteen word pairs (some semantically related, others not) to Alex. If the words are related, then the pair may be 'carrot-vegetable' and if they are unrelated, then the pair may be 'bread-window'. After going through the set, the examiner reads one of the words to Alex who must respond with the corresponding word pair. This is repeated four times, with the presented words in a different order each time. The first part of the verbal paired associates II subtest, is the replication of the first part, but once again after a time delay. Similar to the logical memory II subtest, Alex's recognition abilities are tested. She must identify whether word pairs being read to her were heard in the initial condition, or if they are new pairs altogether. Finally, her recall is tested again, and she is asked to list every word pair she remembers. Alex struggles on all of these tasks, but performs better when the words are related than when they are not. Both sets of tasks gauge auditory memory, but the logical memory subtests, Alex's answers must be more cohesive in contrast to her one word answers given in the verbal paired associates subtests, giving a good estimate of her range of abilities.

There are also four assessments in the visual memory index: visual reproduction tests (I & II) and designs tests (I & II). The visual reproduction subtests evaluate nonverbal visual memory. More specifically, the visual reproduction subtest I shows Alex five different designs for ten seconds at a time. Immediately following seeing each design, Alex must draw it to the best of her ability. Tasks involving drawing may scare patients who do not feel they are artistically inclined, but the scoring does penalize patients whose designs only differ in beauty.

Like the previous memory tests, the visual reproduction II subtest replicates its first condition but after a time delay. The tester may alert Alex during the initial subtest that she should try to remember each design, as a small hint for what is to come. After completing the task again, her recognition is tested as expected. Alex is shown six designs and must identify which matches those from the original presentation. Finally, the neuropsychologist may ask Alex to copy the designs while she looks at the pictures -- this can help see her baseline drawing abilities and motor skills if there is a question regarding how to score her recalled replications. She does well in this copy condition, but poorly in the immediate recall, proving that her inaccurate drawings were based on memory problems. Next, Alex is given the designs subtests which test her spatial memory for previously unseen visual stimuli. In the designs I subtest, Alex sees a grid of four to eight designs for ten seconds. Once the grid is removed from her view, Alex is given a set of cards with designs on them and she must arrange these cards to match the grid she has just seen. Following the pattern of all the previous tests, the designs II subtest begins as the same task with a time delay and continues with a recognition condition. In a recognition condition, Alex is shown a grid similar to the immediate condition, and must identify which designs were part of the initial task, and which are in the same positions. Again, while all of her results are below average, she performs slightly better on recognizing the correct designs. These tests differ from each other as the visual reproduction subtests rely more on recall in comparison to the designs subtest which rely more on recognition. Furthermore, spatial memory is more clearly measured in the designs subtests, as the stimuli in the verbal reproductions subtests include designs that are easier to name, meaning that using verbal cues may help assist in memory. Although they are part of the same index, there are differences in the tests that serve to make the WMS-IV as a whole more reliable.

The last index of the WMS-IV measures working memory and it has two parts: the spatial additions and symbol span tests. The spatial addition test is only taken for a certain age range (16-69) and still being in her sixties, Alex just meets this cutoff. More specifically, the task tests visuospatial working memory. Two grids are revealed one after the other for five seconds, and each have red circles, blue circles, or both. Using more specific directions from the tester, Alex must add or subtract the locations of either the blue or red circles. Since this is a specific test for working memory, there is no delayed condition. The final subtest of the WMS-IV is the symbol span test which evaluates visual working memory. For a short amount of time, Alex sees a set of various abstract symbols. Immediately after, she is presented with an array of symbols that include the originals and ones that she has never seen. Not only does Alex have to pick the designs she has already seen, but it must be done in the order in which they were presented to her. Once again, while both measuring working memory, the tests assess different functions -- spatial addition with recall and symbol span with recognition. Throughout the WMS-IV evaluation, Alex's results seem to be obviously lacking compared to those without cognitive impairments, but it is important to note that there is still a scoring scale in place to be more precise in identifying the deficits. If Alex's score is low, the neuropsychologist can be fairly sure that she has some type of dementia. To attempt to confirm this, there are also dementia-specific neuropsychology tests including the Mini-Mental State Exam (MMSE). This brief assessment measures language, working memory, attention, comprehension, motor skills, and other important cognitive functions (National Institute on Aging 2020) . Even if Alex's score on the MMSE is adequate, the neuropsychologist will still try to start an immediate therapy to slow down disease progression and will work with her other doctors and family to make sure she has assistance in her day to day life.

Visuospatial Perception

An important function of the brain that many people take for granted is the ability to visualize objects and understand its relative spatial location to the rest of its environment. These visuospatial functions are necessary for us to find objects in space, and to navigate our environment with appropriate orientation (Pena et al., 2008) To test a patient's visuospatial abilities, they need to complete tasks that involve imagining objects, mentally reconstructing parts of an object into a whole, and evaluating entire areas of space ("Visuospatial ability", 2020). For this example, a middle aged man named Brady suffered a stroke that damaged his right parietal lobe. Following the stroke, Brady has mostly recovered, but still exhibits abnormal behavior, such as not shaving the left side of his face and only eating food from one side of his plate. When confronted with questions regarding his obscure behavior, Brady jokes about it, not showing any signs of fear or concern about his eccentricities. Due to his actions that show he is not acknowledging an entire half of his visual space, Brady's doctor refers him to a neuropsychologist to test the extent of this problem, and possibly provide a diagnosis, as these symptoms are common of hemispatial neglect. There are many different tests that the neuropsychologist can administer to assess Brady's visuospatial deficits, but here he will use three of the most common ones: the Rey-Osterrieth Complex Figure, Hooper Visual Organization Test (VOT), and the Clock drawing test.

The Rey-Osterrieth Complex Figure test is used to test not only visuospatial abilities, but also memory, planning, attention, and executive functioning, making this a very popular assessment among neuropsychologists. This task produces visual results, so the amount each patient deviates from average is easy to identify in a salient manner. Shin et al. (2006) explains the process of this test. Brady will take this test in four conditions: copy, immediate recall,

delayed recall, and recognition. Initially, the administrator provides Brady with an image or figure with unique patterns and shapes. The copy condition is straightforward. -- Brady sees the figure and must copy it to the best of his ability on another piece of paper. While Brady does not have to complete the task in a certain amount of time, the administrator will still track how long it takes. The tester will also note in what order Brady copies the figure. These two measures are just more ways to compare Brady's visuospatial functions to the normative data. Directly after he has finished copying the figure, the administrator removes both the original figure and Brady's copy and the immediate recall condition begins. Just as it sounds, Brady now has to replicate the original figure once again without the aid of any reference other than his memory. The same variables are measured in this condition as in the copy condition, with the only difference being adding the element of recall. Once Brady is finished, he waits thirty minutes and redoes the same task, which is fittingly called the delayed recall condition. After these three similar conditions, the administrator may have Brady do the recognition condition. In this part of the task, Brady is presented with various patterns and details, some of which were parts of the figure he has just drawn three times. Instead of showing he remembers the image by physically drawing it, he simply has to circle the details that were part of the original figure. According to the University of Zurich (2020), this task is scored by dividing the figure into eighteen separate parts. Each part is graded based on if Brady copied the details correctly and if he copied the details in the correct position. The scoring system itself is very clear: two points if the details are accurately drawn and placed (one point if one of those things is done and not the other), half a point if the drawing is neither drawn or placed correctly but it is recognizable, and no points are rewarded if it is completely wrong and unrecognizable. Brady receives a low score as his copies show clear impairments. The right side of his pictures have relatively accurate drawings, but the

left side is completely blank, indicating that he was unaware of an entire half of the original stimulus, supporting a diagnosis for hemineglect. To be sure of this diagnosis, the neuropsychologist will administer a few more supporting assessments.

An even simpler task than the The Rey-Osterrieth Complex Figure is the clock drawing test, whose name alone is enough to explain its procedure. As summarized by Agrell & Dehlin (1998), Brady is given a blank paper with instructions to draw a clock, and although it sounds straightforward, there are actually two conditions to this task -- free-drawn and pre-drawn. In the untimed free-drawn method, Brady must draw a clock from memory. In the untimed pre-drawn method, Brady is presented with a circle, and from there is expected to add the numbers of a clock onto what he is given. Whether the clock's hands are drawn is determined by the neuropsychologist, as sometimes patients are instructed to indicate that the clock is set to a certain time. Once again because this is a visual test, oftentimes the results are relatively self-explanatory. If numbers are missed, if the space between the numbers is too big or too small, or if the circle itself is not drawn with relative accuracy then there is a problem. Brady is asked to complete the pre-drawn condition, and he includes every number on the clock -- but all confined to the right side of the image. This represents an obvious impairment in his visuospatial abilities, but Brady is still asked to take one more assessment.

Finally, Brady is given the Hooper Visual Organization Test (VOT). In this task, Brady sees thirty different objects, one at a time. Each object is deconstructed from the whole into different parts and Brady must identify what the object is (ScienceDirect Topics, 2021). For example, a picture of a flower is cut apart and randomly rearranged so adjacent parts are not next to each other. Brady must have the mental abilities to mentally reconstruct the various images to make a cohesive, identifiable whole. Brady's score is just the number of images he was able to

accurately name. He is able to reorganize the parts of the image that he sees on the right side of his visual field, so if those parts are enough for him to see the bigger picture, then he was able to identify the image. Now, the neuropsychologist consolidates the results from this test, the Rey-Osterrieth Complex Figure, and the clock drawing task to provide a diagnosis, which looks like a fairly clear case of hemispatial neglect which corresponds to the brain injury he had suffered from. With a more accurate view on his deficits, Brady works with his neuropsychologist to help find the most specific and appropriate therapies in hopes of gaining back standard visuospatial abilities.

Executive Functioning

In the brain, the frontal lobes use information from the posterior cortex to carry out executive and control functions such as planning actions and understanding abstract concepts (Ogden 2005). If damaged, people have a hard time initiating actions, having cognitive flexibility, problem solving, making decisions, and being motivated. These challenges can have a debilitating effect on someone's day to day life and they may be completely different from the person that existed before their brain damage. Frontal lobe dysfunction can arise from many problems, including neurodegenerative diseases, strokes, and traumatic brain injuries. In this example, a college professor (and loving father to young children) named Teddy was attacked on the street and was left in a coma. There was significant damage to his frontal lobes, and after he woke up and began to recover, he was able to leave the hospital to go home. Upon returning to his children, his behavior became more spontaneous and his decision making worsened. This culminated in abusive, impulsive punishments towards his children that resulted in criminal charges for child endangerment. The court and his doctors wanted to evaluate his cognitive abilities to understand what was spared and what was lost after his accident, so as to know if his

actions were out of malice or simply from brain damage. So, Teddy was referred to a neuropsychologist to assess the severity of his impairments to determine if his behavior stemmed from this frontal lobe dysfunction. Again, other tests from different categories (WAIS-IV, WMS-IV, Rey-Osterrieth Complex Figure) can be used as evaluations but there are also more specific ones to measure executive functioning, such as the Wisconsin Card Sorting Task (WCST) and the Trail Making Test.

Ogden (2005) details how the Wisconsin Card Sorting Task is used to test executive and control functions. More specifically, it evaluates one's capabilities in forming abstract concepts, problem solving, strategy planning, memory, attention, and recognizing errors and thus changing behaviors. In this task, Teddy has a stack of cards with different designs on them and the cards can be categorized by the design shape, color, and number. There are four cards in front of him, and he is instructed to sort the cards in his stack one at a time into one of these four options. The category in which Teddy must sort the cards is not explicitly said to him, but rather given through feedback from the administrator after each card is placed on one of the piles. From here, Teddy will continue to use the same sorting strategy if his choice was correct, or he will attempt to correct it with the next card. For example, imagine someone without frontal lobe dysfunction pulls a card with one red circle on it. Thinking the cards of the same color should go together, he places it on the card in front of him that has three red squares. The tester tells him this is wrong, so he tries to think of another way to sort the cards. He determines that they should not be sorted by color but rather by shape, and when he makes this switch the tester informs him that it is correct and he continues with this strategy. To keep testing the ability to see patterns and change strategies, the administrator changes the rules without telling the participant who now must go through this same process to find the new sorting method. Those with frontal lobe dysfunction

like Teddy will likely have trouble with this task, which can manifest itself in multiple ways. In the most severe of cases, he could not even understand the idea of sorting as this is an abstract concept. More likely though, he will have difficulties learning from his errors and changing behaviors based on the feedback that is given; furthermore, changing the sorting rules midway through the task will cause an even greater challenge. This is where Teddy struggles. He may initially figure out the rule that the tester has set for him to follow, but once that rule changes his behavior and strategy will not adapt. The inability to alter behavior based on feedback and changing one's mental set is synonymous with frontal lobe dysfunction, and there are more tests to determine this.

According to (Ogden 2005), the Trail Making Test is another evaluation that is very sensitive to brain damage and cognitive impairments since it is based on response speed, mental tracking, and task switching abilities. There are two parts to the task, but they are very similar to each other. In part one, Teddy is directed to connect circles that are consecutively numbered on a page. In part two, Teddy does the same thing, except that the page is filled with both numbers and letters and he must connect them in alphanumeric order, alternating between the numbers and letters (1,A,2,B…). If Teddy makes an error, the administrator will inform him. For both parts, the score is simply the time for him to correctly connect all the circles. Teddy has challenges completing part two of the Trail Making test, as even after corrections, he will not include the letters in his connections. This result shows an inability to change mental sets. A mental set refers to sticking with familiar strategies that have worked in the past to solve current solutions (Huang et al., 2018). If the strategy of connecting the numbered dots was met with positive feedback in part one (which should be the case), then those with frontal lobe damage may have trouble departing from this seemingly working approach to the task. Again, this is due

to the frontal lobe's control of decision making and problem solving. Throughout the two tasks, Teddy exhibits clear behavioral problems in relation to his frontal lobe damage. These results confirm that Teddy may be at risk taking care of his children, and even himself, due to the impairments in planning and decision making. Therefore, his children are taken out of his custody, and his impaired mental capacity keeps him from being charged with any crimes.

Conclusion

Just like seeing a general physician, the experience of seeing a neuropsychologist and taking a neuropsychological test will not be the same for every individual. Despite the implausibility of this experience being universally identical, this overview should encompass the most general aspects. It is unlikely that any given patient will be referred to complete all the given tests above, but the examination they do take will come from one of the five summarized categories. Throughout the examples, the different purposes of neuropsychological assessments are showcased. With Amy, we see how the WAIS-IV helps determine the extent of which someone with an intellectual disability can live independently. By taking the BDAE, Mary's doctors are able to particularize her diagnosis since one of the specific subscales helps to differentiate two similar disorders. Alex, a woman suffering from memory problems with strong genetic ties to dementia, takes the WMS-IV and the MMSE to track the progression of her memory impairments. Brady completes the Rey-Osterrieth Complex Figure, the (VOT), and the Clock drawing test in order to assess his deficits following a significant stroke. Finally, Teddy is referred to take the WCST and the Trail Making Test to assess his mental capacity after being charged with child endangerment recently following his brain injury.

Despite each person taking different tests for different purposes, the general process should not deviate greatly between individuals. For whatever reason, a patient is referred to take

a neuropsychological test by someone in charge of their wellbeing, alleviating the possible struggle of a patient having to find their own neuropsychologist. Prior to the examinations, patients will have a chance to talk to the psychologist in a casual interview where they will then be able to ask questions, express concerns and fears, and explain the problems they believe are impairing their lives. The test itself will normally take up to a couple hours -- depending on what cognitive feature needs to be assessed -- and will be in a stress-free environment. A neuropsychologist's main goal is to make their patients feel comfortable so that they can perform at their highest potential. Once the tests are over, the neuropsychologist will inform whoever made the referral of the results. At this point, each patient will have an individual experience because the next step may be creating a treatment plan, diagnosing a disorder, identifying the progression of a disease, or determining how much assistance one requires. Only the tip of the iceberg of available neuropsychology tests has been covered, and even the ones reviewed will soon have updated versions that may include or exclude different elements. This is not to say that this material will be irrelevant anytime soon, but rather to show how extensive this branch of psychology is, and that scientific discoveries and improvements will forever continue to impact neuropsychology. Referring back to the opening example of Timmy, a simple neuropsychology test may be the reason for a teacher understanding a sudden drop in grades. However, in the most serious cases, these assessments can be the difference between life and death and it is imperative to understand their importance in psychology and beyond.

Works Cited

Agrell, Berit., & Dehlin, Ove. (1998). The clock-drawing test. *Age and Ageing*, *27*(3), 399–403. https://doi.org/10.1093/ageing/27.3.399

American Academy of Clinical Neuropsychology . (2018, March 27). *Adult Neuropsychology*. AACN. https://theaacn.org/adult-neuropsychology/.

American Addiction Centers. (2020). *Psychological Testing: Wechsler Adult Intelligence Scale*. Mental Help Psychological Testing Wechsler Adult Intelligence Scale Comments. https://www.mentalhelp.net/psychological-testing/wechsler-adult-intelligence-scale/.

Dementia & Neuropsychologia, *2*(3), 201–205. https://doi.org/10.1590/s1980-57642009dn20300007

Figueiredo, S. (2012, October 25). *Boston Diagnostic Aphasia Examination (BDAE)*. Strokengine. https://strokengine.ca/en/assessments/boston-diagnostic-aphasia-examination-bdae/.

How To Become Neuropsychologist. CareersinPsychology.org |. (2020, October 30). https://careersinpsychology.org/becoming-a-neuropsychologist/.

Huang, F., Tang, S., & Hu, Z. (2018). Unconditional Perseveration of the Short-Term Mental Set in Chunk Decomposition. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.02568

Maccow, G. (2011). *Wms-Iv: Administration, Scoring, Basic Interpretation*. Lecture.

National Institute on Aging. (2020, October 7). *Mini-Mental State Exam (MMSE) Alzheimer's / Dementia Test: Administration, Accuracy and Scoring*. Dementia Care Central. https://www.dementiacarecentral.com/mini-mental-state-exam/.

Neuropsychological Evaluation FAQ. Department of Neurology. (2021, February 1). https://www.med.unc.edu/neurology/divisions/movement-disorders/npsycheval/.

Ogden, J. A. (2005). *Fractured minds: a case-study approach to clinical neuropsychology*. Oxford University Press.

Pena, M. C., Sobreira, E. S., Souza, C. P., Oliveira, G. N., Tumas, V., & Vale, F. de. (2008). Visuospatial cognitive tests for the evaluation of patients with Parkinson's disease. *Visuospatial ability*. NeuRA Library. (2020, September 8). https://library.neura.edu.au/schizophrenia/signs-and-symptoms/cognition/visuospatial-ability/.

ScienceDirect Topics. (2021). *Hooper Visual Organization Test*. Hooper Visual Organization Test - an overview. https://www.sciencedirect.com/topics/medicine-and-dentistry/hooper-visual-organization-test.

Shin, M.-S., Park, S.-Y., Park, S.-R., Seol, S.-H., & Kwon, J. S. (2006). Clinical and empirical applications of the Rey–Osterrieth Complex Figure Test. *Nature Protocols*, *1*(2), 892–899. https://doi.org/10.1038/nprot.2006.115

UNC School of Medicine. (2021, February 1). *Neuropsychological Evaluation FAQ*. Department of Neurology.

https://www.med.unc.edu/neurology/divisions/movement-disorders/npsycheval/#:~:text=A%20complete%20evaluation%20generally%20takes,time%20required%20for%20an%20evaluation.

University of Zurich. (2020, October 29). *Rey Figure Project*. UZH. https://www.psychology.uzh.ch/en/areas/nec/plafor/Rey-Figure-Project.html