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The Draw-a-Person Test in Neuropsychological Assessment

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ABSTRACT

The Draw-a-Person test (former Draw a Man test) comes from the intelligence diagnostics of children, but the procedure also gives a wealth of interesting results in patients with brain damage.

***Goal**: The aim of the study was to investigate to what extent drawing ability is impaired in people with brain damage and how strong the connection is with other neuropsychological investigations.*

***Methods**: The result of the Draw-a-Person test (DAPT) was compared with the: Mini-Mental Status Examination, Verbal Learning and Memory Test, Number Connection Test, "Personalities" test from Kaufmann's Test battery, Hooper's Visual Organization Test and Mosaic test of the Hamburg Wechsler intelligence Scale.*

***Participants**: The data was collected as part of a field study in a clinic for Neurology and a neuropsychological practice, so there are often only preliminary diagnoses. Since this study is about the correlations of the tests only, differences in diagnosis are not considered as a bias. For the present study, the data from a total of 50 patients (mean age 70.2 ±13.0 years, 24 males, 26 females) were evaluated. The patients suffered from: stroke (n=19), dementia (n=10), traumatic brain injury (n=5), transient ischemic attack (n=4), heart attack (n=3), encephalitis (n=2), Parkinson's disease (n=2), cerebral hemorrhage (n=1), other diagnoses (n=4, e.g. vitamin-B12 deficiency, seizures, confusion).*

***Results**: The correlations to the DAP-Test were: Mini-Mental Status Examination Rho=0.66*; Verbal Learning and Memory Test 1st round: Rho=0.34*; 5th round: Rho=0.44*; 6th round: Rho=0.23 (n.s.); 7th round: Rho=0.30 (n.s.); Number Connection Test Rho= -0.29*; "Personalities" test Rho = 0.44*; Hooper's Visual Organization Test Rho = 0.61*; Mosaic Test Rho = 0.57*.*

***Conclusion**: The DAP test is an easy-to-perform procedure that only takes a few minutes and is very economical. The test gives initial indications for many visual-constructive deficits as e.g. neglect, visual agnosia and correlates significantly with many other neuropsychological instruments.*

Keywords

Draw a Person Test, Draw a Man test, Draw a Human test, Draw a figure test, Neuropsychological assessment.

Introduction

The Draw-a-Person test (DAPT) comes from the intelligence diagnostics of children, but the procedure also gives a wealth of interesting results for patients with brain damage. Neuropsychological tests that require drawing, as e.g. the Clock test [1], the Benton test [2], the Göttingen Form Reproduction test [3,4], are well-known methods in the diagnosis of neurological diseases and cognitive deficits [5]. These instruments investigate,

in addition to visual-spatial perception, the ability to draw objects. The Benton-Tests even investigates the short-time memory. However, the Draw-a-Person test has not yet been routinely used in neuropsychological diagnostics.

Florence Laura Goodenough developed the "Draw-a-Man" test in 1926 to record the developmental stage in children [6,7]. Children's ability to draw people develops from around the age of three to five years and then steadily improves until young adulthood [8]. Based on Goodenoughs results, Hermann Ziler designed the "Mann-Zeichen-Test" (Draw-a-Man test) in 1949, also with the aim of assessing children's readiness for school [9]. On children aged 4 to 14, he standardized and normed his test by evaluating 1,651 children's drawings. Especially in the 1960s, this method was often used as an indicator for the developmental level of children [10].

The test particularly takes into account visual-motor skills, imagination, but also observation skills and intelligence [11,12]. This instrument has therefore become a frequently used procedure, particularly in the areas of pedagogic and educational psychology [13]. The way in which the person is drawn, e.g. how tall it is on the sheet of paper, the position on the page and whether the person drawn is depicted with short or long arms and legs can even be interpreted in the sense of a psychoanalytic projective test-method. Often these aspects are cultural influenced [14]. The test can therefore also be used in the therapeutic area to find out something about the personality of the little artist [15].

Further research work came, for example, from Richey [16] or Crooke [17]. In 1972 Horn published the "Begabungs Test System" (B-T-S), an intelligence test which includes the task to draw a man as a subtest and also gave new normative data [18]. The evaluation contains 50 individual criteria (e.g.: Has the figure a head, body, eyes, nose, mouth, arms …?) and, for the first time, also specifies additional values for adults. Schmalohr and co-authors developed in 1974 new normative date [19]. In 2007 Brosat and Totemeyer [20] changed the evaluation criteria and renamed the test as Human Drawing test, since it ultimately did not matter for the test evaluation whether a man, a woman or a child was drawn. The instruction is: "Please draw a person as best you can".

In 2007 Fliegner [10] developed a special DAPT quotient for children of different ages and again updated the evaluation norm values, as these were partly outdated due to social and cultural changes (e.g. wearing a hat gave one point). While there is a constant improvement in children's drawings (see e.g. [21]), most people's painting skills apparently hardly improve after they leave school. In most versions of this tests there is therefore only one standardization for adults (e.g.: [18]).

In 2019 Chollat and co-authors examined the association between the test and behavioral and cognitive disabilities in premature infants [22]. In 2020, Papangelo [23] and co-authors tested human figure drawing performance in children with autism spectrum disorders, compared to typically developing controls. According to the authors, the Human drawing test can be used to examine dependencies between drawing performance and to show neuropsychological characteristics and thus possibly provide clues about how autism works. In 2022, Horiuchi and co-authors [24] examined the effectiveness of the test as a projective measure; here the test was used to identify overadaptive tendencies in girls aged 6-8 years.

When we get older, the ability to draw a person often deteriorates. Many older people are more likely to draw a person on the same level of ability as schoolchildren. Especially when dementia sets in, those affected usually have considerable difficulties depicting a person visually [25]. Patients with brain damage, particularly in the parietal parts of the brain, often show massive deficits in the ability to draw objects [26]. Incorporating the Draw a Person Test (DAPT) into routine adult neuropsychological assessments is important for several significant reasons, each enhancing a comprehensive understanding of an individual's cognitive and emotional functioning. The DAPT offers insights into cognitive abilities that other standardized tests might not fully address.

The DAPT provides an extensive evaluation of visuospatial skills, motor control, and creative thinking. By instructing individuals to draw a human figure, the test measures their ability to perceive and replicate spatial relationships, a vital aspect of everyday functioning often impacted by neurological conditions. Additionally, it assesses fine motor precision, reflecting the integrity of motor pathways and control, essential for tasks such as writing and tool use. Furthermore, the DAPT is an effective screening tool for identifying neurological and psychological issues. It can detect subtle indicators of conditions such as stroke, traumatic brain injury, and neurodegenerative diseases like Alzheimer's, which frequently affect drawing capabilities. Moreover, the test can uncover emotional disturbances like anxiety and depression, which may be reflected in specific drawing features, such as missing facial elements or disproportionate figures, offering insights that verbal tests might miss. Additionally, the DAPT is an exceptional nonverbal assessment tool, especially valuable for individuals with verbal communication difficulties. This includes patients with language disorders like aphasia and those from diverse cultural and linguistic backgrounds who may find language-based assessments challenging. The nonverbal nature of the DAPT enables these individuals to showcase their cognitive abilities without the hindrance of language, leading to a more accurate and inclusive evaluation.

Over time, the DAPT can play a crucial role in monitoring cognitive changes. Through ongoing assessments, clinicians can track the evolution of an individual's drawings, offering a visual and qualitative gauge of disease progression or improvement. This longitudinal approach is particularly valuable for evaluating treatment effects, as changes in the complexity and accuracy of drawings can provide tangible evidence of therapeutic effectiveness. Moreover, the DAPT enhances comprehensive neuropsychological assessments by contributing qualitative data that enriches overall evaluation. While tests such as the Mini-Mental Status Examination (MMSE) or verbal learning and

memory tests provide essential quantitative data, the DAPT offers a distinct perspective, emphasizing visual and motor skills essential for a well-rounded diagnosis. This supplementary information supports and validates findings from other assessments, ensuring a more thorough and precise evaluation of cognitive abilities.

The Draw-a-Person Test has a good evaluation manual and standards for children. Normative data for adults are rare. In addition, there are currently no standards for older people and especially patients with dementia [27]. A first approach to this topic was the (unfortunately unpublished) master's thesis by Johanna Petersen ("Pilot study on the standardization of the man sign test as a diagnostic tool for dementia" [28]), which was written at the Medical School Hamburg (Germany) in 2017, but which only contained a very small number of study participants and only a comparison of the Draw-a-Person test with the Mini Mental Status Examination [29,30].

In summary, incorporating the Draw a Person Test into routine adult neuropsychological assessments enhances the ability to diagnose and understand a wide range of cognitive and emotional conditions. Its unique contributions in evaluating visuospatial skills, motor control, nonverbal communication, and psychological state make it an indispensable tool for providing comprehensive care and effective treatment planning. There is already a well-established visuospatial test, the Clock Drawing Test, which assesses visuospatial and executive functions. The Draw a Person Test (DAPT) and the Draw a Clock Test (DCT) are both valuable tools for neuropsychological assessment, each offering unique insights into cognitive and motor functioning. However, the DAPT can provide additional insights that enhance a comprehensive assessment.

The DAPT involves drawing a human figure, which appears to require more complex integrations of cognitive functions than the relatively simple task of drawing a clock [1]. This complexity allows the DAPT to assess a broader range of cognitive abilities. For example, the DAPT assesses visual-spatial abilities through the detailed spatial understanding required to accurately represent human anatomy. It also assesses motor skills and precision more sensitively, as detailed body parts such as fingers and facial features need to be drawn. In addition to cognitive abilities, the DAPT can also reveal aspects of a person's emotional and psychological state that the DCT may not capture [28]. Drawing a human figure, particularly a self-portrait, provides insights into a person's self-image and self-esteem that are not captured by the DCT. In addition, the characteristics of the drawing, such as facial expression, posture and the inclusion or omission of certain body parts, may indicate emotional disorders such as anxiety, depression or body image issues.

The DAPT may also be more effective in detecting specific neurological and psychological conditions [26,31]. For example, the DAPT may reveal deficits associated with damage to the parietal lobe, such as difficulties with body schema and spatial relationships, which may not be as evident on the DCT. In addition, the DAPT can provide evidence of psychiatric disorders such as schizophrenia or major depression through atypical or distorted drawings, thus offering a broader diagnostic spectrum than the DCT. In addition, the DAPT is valuable for the assessment of developmental and educational issues [32]. In children and adolescents, the DAPT can help assess developmental stages and identify delays or atypical development in motor and cognitive skills. The detailed analysis of drawing skills can allow for targeted educational and therapeutic interventions that may be less evident with the DCT.

While the Draw a Clock Test is a powerful tool for assessing cognitive decline, particularly in conditions such as dementia, the Draw a Person Test provides a more comprehensive assessment of cognitive, motor and emotional functioning [15]. Its ability to assess a broader range of abilities and provide deeper psychological insights makes the DAPT a valuable addition to routine neuropsychological testing. By incorporating both tests, clinicians can gain a more nuanced and thorough understanding of a person's cognitive and emotional state.

The aim of the study presented here was to investigate to what extent drawing ability is impaired in people with brain damage and how strong the connection is with other neuropsychological test results. These tests were routinely administered at the selected clinics. The number of points of the draw-a-person test was compared with the Mini-Mental Status Examination, the Verbal Learning and Memory Test, the Number Connection Test, the “Personalities” test from Kaufmann's Test battery for intelligence testing, the Hooper's Visual Organization Test and the Mosaic Test of the Hamburg Wechsler Intelligence Test for adults (see below). For the Hooper's Visual Organization Test and the Mosaic Test of the Hamburg Wechsler Intelligence Test for adults, a high correlation was expected; both tests investigate visual perception. For the Mini-Mental Status Examination, the hypothesis was that medium correlations would be found, as the test also includes a drawing task. With regard to the Number Connection Test, only a low correlation would be expected, as the test only requires drawing a line from one number to another, without any great demands on creativity. For the Verbal Learning and Memory Test, only a weak correlation was expected, as it is a pure memory test and no drawing is required. The “Personalities” test from Kaufmann's Test battery for intelligence testing is a pure memory test for cognitive abilities; here, too, only a weak correlation was expected.

The goal of this work was not to develop norms for older people or for patients with brain damage, but rather to show whether the DAPT really does provide useful data for assessing visually constructive skills, i.e. to investigate the convergent validity of the DAPT.

Methods

For neuropsychological investigations, a set of routinely conducted tests was used. The data was collected over the last 7 years. In the neurology clinic in particular, there were only acute patients and only limited time was available (maximum 90 minutes). Therefore,

only important basic variables were recorded, i.e. attention & working speed, memory and visual-constructive skills. For the latter, only 3 tests were used, the DAPT, the Hooper's VOT and the mosaic test. Unfortunately, a comparison of the results of the DAPT with other visual-constructive tests such as the Clock-Test or the Rey-Osterrieth figure was not included. Because the study had to be individually adapted to the deficits of each patient, not all data are available for all patients.

The following test procedures were relevant to collecting the data:

Draw-a-Person Test (DAPT): As described above, the person being examined is instructed to draw a person as best as she/he can. Points are awarded based on existing body parts (e.g. presence of arm, nose, lips, ears, fingers, palm, etc., one- or two-dimensional representation, richness of details). The test asks about various high specific details, e.g. whether the eye has a pupil, whether the lines meet exactly or overlap, whether the hand has five fingers and the thumb can be separated from them, etc. The value range in the norms of the "Begabungs Tests System" according to the version of Horn is between 0 and up to a maximum of 50 points [18].

The Mini Mental Status Examination (MMSE) was developed by Folstein and colleagues in 1975 to provide a screening procedure suitable for everyday clinical practice to determine cognitive deficits, particularly for dementia testing [29,30]. Central cognitive functions are tested using 9 task areas (temporal and spatial orientation, ability to remember, attention, language and language comprehension, as well as reading, writing, drawing and arithmetic). The procedure usually takes around 10 minutes. The tasks of the MMSE include both, answering questions and carrying out simple actions (e.g. "What year is it?", repeating of words, folding a piece of paper and placing it on the floor, tracing two pentagons, etc.). The German version was made from Kessler, Denzler & Markowitsch in 1990 [33]. A modified version is from Tombaugh, McDowell, Kristjansson & Hubley [34]. Despite its widespread use, the MMSE has a lack of sensitivity and specificity, which is why a final diagnosis can only be made with further and better-founded neuropsychological examinations [5].

"Personalities" is a subtest from the Kaufman's test for measuring intelligence in adolescents and adults [35]. Similar to the more popular "Famous Faces Test", portraits of famous people are shown and the patient is asked to name them. The test checks the long-term memory and depends significantly on the patient's age, schooling and cultural background. A total of 42 pictures are presented, although for many items a point is only awarded if two or even all three people given on a sheet are correctly named. The test thus investigates the declarative memory and is heavily dependent on general and history knowledge (see e.g.: [36]).

The Verbal Learning and Memory Test (VLMT, [37]) developed from Helmstaedt, Lendt & Lux in 2001 investigates short-term memory as well as learning structure, working memory and long-term retention. The VLMT is a test for serial list learning with subsequent distraction, recall after distraction and a half-hour delay as well as a recognition test (see e.g.: [36,38]). Each VLMT test includes two lists, each consisting of 15 semantically independent words. There are four parallel test forms for repeat examinations. The first list of 15 words is read out a total of five times and queried after each round. After the 5th learning round, an interference list is read out and queried. Immediately afterwards, without reading the list again, the patient is asked again to remember as many of the words of the first list as possible. After 30 minutes, another query is made without reading it again. It is also possible to recognize task-words from a list of 30 words.

The Number Connection Test is a highly reliable estimate of the "mental speed". It only takes a few minutes. There are different versions of this test, for example the Connect-the-Number-Test uses the number 1 to 10, another version the numbers 1 to 25. Here, we used the version "Zahlen-Verbindungs-Test" (ZVT; [39,40], which is widespread in Germany. The task is, to connect 90 differently arranged numbers with a line on a DINA-4 sheet of paper as quick as possible. The numbers are to be connected by a line in ascending order, starting from 1 up to 90. The implementation time for healthy adults is around 90 - 100 seconds per sheet; in patients with brain damage and dementia it is often significantly longer. There are four parallelized versions (Test A, B, C, D).

The Hooper's Visual Organization Test (VOT) presents images of objects that have been cut into several pieces and are twisted. The patient being examined is supposed to mentally put these cut-up images together and then name them. The process includes a total of 30 cards with pictures showing common everyday objects such as a saw or a lighthouse. The test is considered to be sensitive for damage of the right hemisphere and especially for visual agnosia [41]. The Mosaic Test (MT) is a subtest from the Hamburg Wechsler Intelligence Test (HAWIE-R) [42]. The patient is given a template of a pattern that is to be composed with 4 or 9 cubes. The dices have different colors on each side. There is a time limit for the individual tasks; the faster the examinee completes the respective pattern, the higher the number of points that can be achieved. The test is considered to be particularly sensitive for damage of the right hemisphere, for example patients with agnosia or apraxia.

Participants

The participants come from the neurological department of an inpatient clinic in Lübeck and from a psychotherapeutic practice in Travemünde for outpatients (both in northern Germany). Ultimately, the data from n=50 patients could be evaluated. Since these were routine examinations in the open field, not all of the test procedures described above were carried out on every patient. The selection of the tests to be processed is based on the need to adapt to the patient's specific deficit as quickly as possible and to select, based on theory and experience, the next tests that can best capture the patient's deficit. I.e. the further procedures and selection of additional specific tests was guided by the result of the previous tests. In order not to burden patients with procedures that were unnecessary or far too difficult for them, it was not

possible to examine all patients with all tests. The evaluation of the individual hypotheses therefore always only includes only a subgroup of the n=50. The method for answering the hypotheses were correlations in order to investigate the possible connection between the Draw-a-Person test and other neuropsychological testing results. The significance level was set at the usual $p<0.05$. Raw data and percentage ranks were predominantly used, which allow better comparability of the data with one another and are more understandable than standard norm values such as T-values, Point-Scales or Stanine values. Since standard values usually combine classes of raw values into one standard value, for many tests the raw values are usually much more precise. Since only correlations were calculated, transformation into age standard values was not absolutely necessary.

Inclusion and Exclusion Criteria

The entry criterion was the presence of neurological brain damage including dementia. Exclusion criteria were patients with: appallic syndrome, severe language disorders (e.g. aphasia) or patients with severe paralysis who could not be tested using standard neuropsychological procedures. Patients were also excluded if there was a suspicion that cognitive deficits were due to psychological causes (e.g. severe depression, psychoses). Since patients with dementia were also included in the study, age was not an exclusion criterion [43]. However, patients who were unable to give their own consent could not be included in the data analysis for legal reasons. The test subjects were informed in accordance with the recommendations in the test manuals. It was also ensured that all test subjects understood the instructions. This was ensured by the

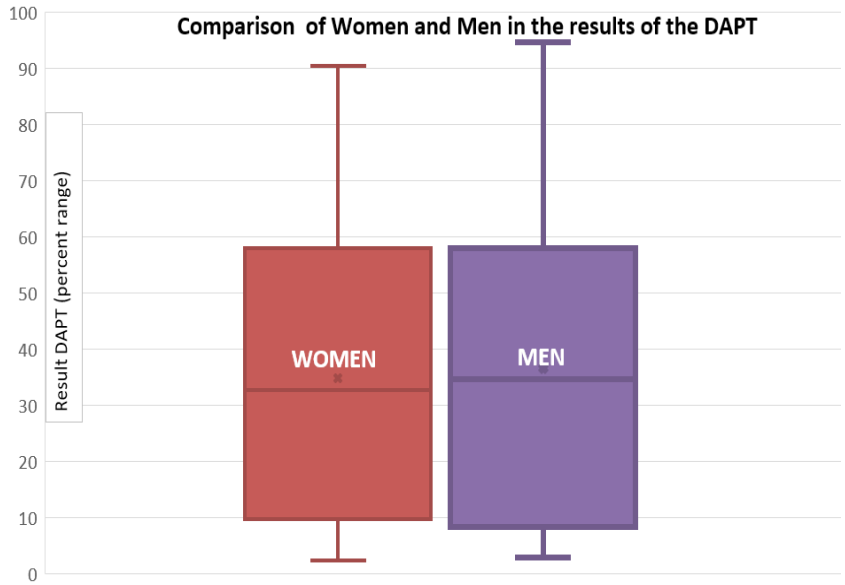

Figure 1.: *Comparison of the results (percentile rank of Draw-a-Person test) between men (blue) and women (red) in this study.*

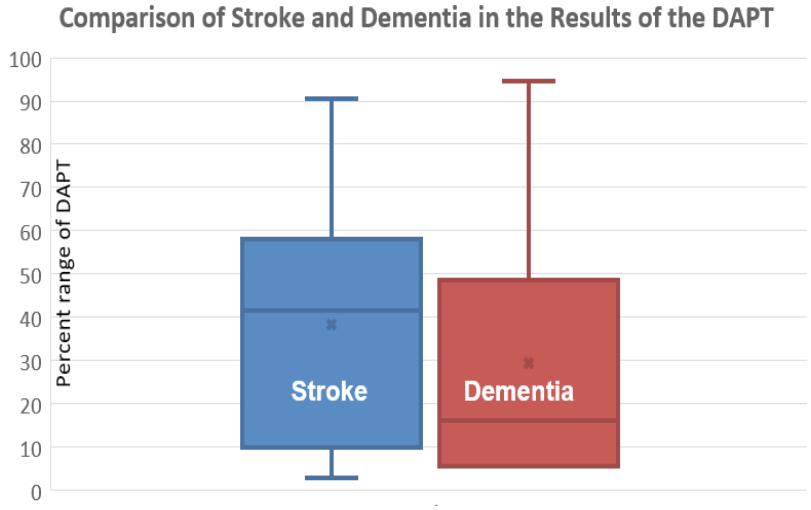

Figure 2.: *Comparison of the results (percentile rank of Draw-a-Person test) between stroke (blue) and dementia (red) in this study.*

experimenters asking specific questions about the tasks of the test inventory and by answering all questions from the test subjects.

For this study, the age of the lesion was not recorded, which even is difficult in chronic diseases, e.g. in dementia. However, several studies have shown that, due to the plasticity of the brain, patients with long-term damage often perform better than patients with recent brain injuries [44]. For the present study, the data from a total of 50 patients (mean age 70.2 years, SD = 13.0 years) were evaluated. The age range was 37 to 89 years. 24 patients were male (mean age 71.3 years, SD = 17.8 years) and 26 were female (mean age 69.3 years, SD = 16.0 years).

A significant difference in the DAPT drawings (overall percentile rank 34.5, SD = 26.9) between men (mean percentile rank 33.6) and women (35.4) could not be determined in this study (U-test p=0.617). The data of both genders can therefore be calculated together (see Figure 1).

Stroke (n=19) was the most common diagnosis; in n=10 patients a suspected dementia was the reason for the examination, n=5 of those affected had suffered an accident with traumatic brain injury (TBI), 4 patients received a diagnosis of a transient ischemic attack (TIA), n=3 patients had a heart attack or heart failure, n=2 suffered from encephalitis, in n=2 patients Parkinson's disease was present, n=1 patient suffered from a cerebral haemorrhage, another n=4 patients received other suspected diagnoses such as vitamin-B12 deficiency, epilepsy, confusion. Table 1 gives an overview.

Stroke and dementia are merely general terms for a variety of different brain injuries. In the case of strokes, for example, the decisive factor is how large the deficient parts of the cerebrum are and where in the brain there is vascular damage. There are different forms of dementia, such as e.g. Pick's disease, Alzheimer's disease or multi-infarct dementia. The differences shown in Figure 2 are therefore only a rough comparison. The group of people with dementia achieves weaker results on average, but this group is also older. However, in order to present the groups examined as accurately as possible, this result should still be presented. Other groups (e.g. trauma, inflammation, etc.) are too small to make any statements.

Results

The first hypothesis supposed that there is a significant positive correlational relationship between the test results of the Mini-Mental Status Examination (MMSE) and the DAPT. The MMSE was chosen specifically because it is a robust tool for evaluating specific cognitive functions and tracking cognitive decline, especially useful in clinical settings for adults. It provides a quantitative measure of cognitive impairment. The Draw a Person Test, while less structured and more qualitative, offers insights into cognitive development, emotional state, and possible neurological issues. It is especially valuable in developmental and psychological contexts, often used in situations where a detailed verbal response may not be feasible. Both tools have their unique strengths and can be complementary in a comprehensive cognitive and psychological assessment. To test the hypothesis, it is now interesting to see whether there is also a statistical correlation between the two measurement instruments. For the MMSE 12 data sets were available out of the 50 patients examined, as this test procedure was mainly only carried out on patients with suspected dementia. For patients with other injuries, the test was often too simple and was therefore omitted due to time constraints. The result of the DAPT was compared with the raw value of correct solutions of the MMSE. The correlation coefficient is Spearmans's Rho = =0.66 and is significant (p=0.045; not significant after Bonferroni correction).

In the second hypothesis was investigated whether there is a significant positive correlation between the test results of the Verbal Learning and Memory Test (VLMT) and the DAPT. The Verbal Learning and Memory Test is a robust tool for evaluating specific aspects of verbal memory and learning, providing detailed and quantitative information about memory function. It is widely used in clinical and research settings to assess and track cognitive impairments, particularly related to memory. Both tools serve distinct purposes and can be complementary in a comprehensive cognitive and psychological evaluation. It is therefore particularly interesting to look for possible correlations here. For the first round of the Verbal Learning and Memory Test (VLMT), which analyses short-term memory after reading aloud the list of words for the first time, 49 data sets were available. Here and in the following analyses, the raw value of correct answers was compared with the result of the DAPT. The correlation between this first pass and the DAPT was Spearman's Rho = 0.34 and is significant. For the 5th round of the VLMT, which tests the gradual development of learning, 48 data sets were available (the test had to be stopped for one patient because he could not remember any words and was completely overloaded by carrying out the test). The correlation of the 5th round with the DAPT was Spearman's Rho = 0.44 and is significant. For the 6th round of the VLMT (after a disturbing list of 15 other words) without hearing the 1st list again, only 39 data sets were available (9 patients felt overloaded by the second word list). The correlation here was only Rho= 0.23 and is not significant. For the 7th round of the VLMT, which checks the memory after another half hour without hearing the 1st list again, there were also 39 data sets. The correlation here was Rho = 0.30 and is not significant. In summary, this hypothesis was formulated too unspecific. There were two significant correlations for short-term memory and learning development up to the 5th learning session, but not for long-term memory.

The third hypothesis checked the correlation with the Number Connection Test (German version: ZVT = *Zahlen-Verbindungs-Test*). The Number Connection Test is a valuable tool for assessing specific cognitive functions such as attention, processing speed, visuospatial ability, and executive function, providing quantitative data that is useful for detecting cognitive impairments and tracking changes over time. Both tools serve distinct purposes. Therefore, it was supposed that there is a significant negative correlation between the test results of the DAPT and the time it takes to

Table 1: Overview of the patients examined. Some of the diagnoses are only preliminary suspected diagnoses, beause many patients were admitted to the clinic acutely (TBI = traumatic brain injury, TIA = transient ischemic attack). Results of the DAPT are as percent ranges, Hoopers VOT is measured in correctly recognized objects, Kaufmann's personalities in correct named personalities, the result of the VLMT means the correct repeated words in the first five session, the Number Connection test listed the time in seconds to complete the task. The list is carried out in chronological order of the time of the examination.

No.	Male / female	Age	(suspected) Diagnosis	DAPT	Hooper's VOT	Kaufmann's Personalities	VLMT 1-5	Number Connection
1	f	73	Stroke	34.5			38	202
2	m	54	B12-deficiency	31.0			29	130
3	m	65	TBI	34.5		19	36	
4	m	78	Dementia	94.5		17	40	400
5	f	47	Stroke	18.4			52	
6	m	83	Nausea	34.5		7	51	
7	f	88	TBI	9.7		27		157
8	f	64	Epilepsy	58.0		22	46	91
9	f	78	Stroke	58.0	24	3	50	
10	f	63	Confusion	2.3	7	23		
11	m	78	Dementia	50.0		9	30	270
12	f	85	Dementia	5.5	12	6	17	
13	f	78	Parkinsonism	7.0	11	2	26	430
14	f	62	Stroke	24.0	21	16	8	222
15	f	68	Stroke	62.0			39	117
16	m	54	TBI	6.7	18		8	
17	f	43	Encephalitis	24.4	26	6	51	73
18	m	77	TBI	42.1	17	9	20	265
19	f	66	Stroke	50.0	22	27		157
20	f	89	Dementia	48.0		12	33	190
21	m	81	Stroke	9.7		24	33	
22	f	85	Stroke	90.3			58	130
23	m	64	Heart attack	5.5		10		145
24	f	55	Stroke	9.7	21	24	25	164
25	m	64	TIA	13.6	24	22	13	545
26	m	82	TIA	90.3		3	11	
27	m	83	Stroke	5.5		3	1	
28	f	64	Stroke	5.5	8	5		
29	m	70	Dementia	5.5		28	21	600
30	m	80	Heart attack	18.4	12	6	56	165
31	f	87	TIA	50.0			50	222
32	f	37	TIA	86.4		11	50	270
33	m	73	Parkinsonism	9.7	15	5	32	245
34	m	64	TBI	61.8		29	21	163
35	m	71	Stroke	6.7	20	27	36	340
36	m	77	Stroke	57.9	24	19	33	95
37	f	85	Dementia	18.4	16	0	20	200
38	f	89	Dementia	13.6	14	39		270
39	m	71	Heart attack	57.9		14		117
40	m	78	Stroke	81.6		14	0	200
41	m	57	Stroke	2.9	6	20		216
42	f	86	Stroke	61.8	10			328
43	f	78	Stroke	42.1				69
44	m	67	Stroke	46.0				130
45	f	77	Stroke	41.0		18	14	300
46	f	57	Cerebr. Hemorrhage	57.9	27	16	66	82
47	m	66	Dementia	5.5		15	1	
48	f	72	Dementia	42.0				
49	f	56	Dementia	9.7			0	
50	f	43	Encephalitis	24.4	26		51	1200

Table 2: Age categories according to Oerter et al. of the 8 most important diagnosis [45].

Illness	*Total*	*female*	*male*	*Teenagers (14-17 years)*	*young adults (18-35 years)*	*Adults (36-65 years)*	*Elderly people (over 66 years)*
Encephalitis	*1*	*1*	*0*	*0*	*0*	*1*	*0*
Dementia	*7*	*5*	*2*	*0*	*0*	*1*	*6*
Cerebr. hemorrhage	*1*	*1*	*0*	*0*	*0*	*1*	*0*
Stroke	*14*	*7*	*7*	*0*	*0*	*2*	*12*
Heart attack	*3*	*0*	*3*	*0*	*0*	*1*	*2*
TBI	*1*	*0*	*1*	*0*	*0*	*1*	*0*
Parkinsonism	*1*	*0*	*1*	*0*	*0*	*0*	*1*
TIA	*4*	*2*	*2*	*0*	*0*	*2*	*2*

Table 3: Matrix of Spearman's Rho-correlations (* = p<0.05). DAPT = Draw a person test, MMSE = Mini Mental Status Examination, VLMT = Verbal Learning and Memory Test summary of 1 to 5, NUMBER = Number Connection Test, PERSON = Kaufmann's Personalities, VOT = Hooper's Visual Organisation Test, MOSAIC = Mosaic test from Hamburg Wechsler Intelligence Scale. Three data of the mosaic test are missing due to a too small number of participants who performed both tests.

	MMSE	*VLMT*	*NUMBER*	*PERSON.*	*VOT*	*MOSAIC*
DAPT	*Rho=0.66* N=12*	*Rho=0.32 N=37*	*Rho= -0.29 N=37*	*Rho=0.44* N=37*	*Rho=0.61** N=22*	*Rho=0.57** N=8*
MMSE		*Rho=0.66** N=10*	*Rho= -0.36 N=9*	*Rho=0.69* N=10*	*Rho=0.80 N=4*	*N=0*
VLMT			*Rho= -0.55* N=28*	*Rho= 0.43* N=27*	*Rho= 0.36 N=16*	*Rho=0.21 N=7*
NUMBER				*Rho= -0.31 N=26*	*Rho= -0.56 N=17*	*Rho=0.94 N=6*
PERSON.					*Rho=0.35 N=19*	*N=2*
VOT						*N=2*

complete the Number Connection Test (ZVT). There were n=37 participants with valid data sets for the Number Connection Test. The average processing time in seconds was compared with the percentile rank of the DAPT. In contrast to the other hypotheses, a negative correlation was to be expected here, i.e. the better the result of the DAPT, the lower the result of the ZVT in seconds of processing time. The correlation coefficient is Spearman's Rho = -0.29 and is not significant (p=0.098). The alternative hypothesis can be substantiated.

The H4 investigated if there is a significant positive correlation between the test results of the DAPT and the "Personalities" test from the Kaufmann's test battery for long-term memory. The Kaufman Assessment Battery long-term memory subtest is a robust tool for evaluating various aspects of memory, providing detailed and quantitative information about memory function. It is widely used in clinical and research settings to assess and track memory-related cognitive impairments. Both tools serve distinct purposes and can be complementary in a comprehensive cognitive and psychological evaluation, providing a well-rounded understanding of cognitive functioning. For this analyses n=37 data sets were available. The correlation coefficient was Rho = 0.44 and is significant (p=0.008, even significant after Bonferroni correction).

The fifth hypotheses asked, whether there is a significant positive correlative relationship between the test results of the DAPT and the Hooper's Visual Organization Test (VOT). The Hooper Visual Organization Test is a valuable tool for evaluating visual perception, spatial skills, and visual organization, providing detailed and quantitative information about visual processing abilities. It is widely used in clinical and research settings to assess and diagnose visual-spatial impairments and track changes over time. Both assessments have unique objectives and can complement each other in a thorough cognitive and psychological evaluation, offering a holistic view of an individual's visual processing, cognitive abilities. To calculate the relationship, the number of correctly recognized objects in the VOT was compared with the result in the DAPT. However, there were only n=22 data sets available because the test was mainly used in patients with right hemisphere lesions and suspected deficits in the visual-constructive area. This comparatively small number is unfortunate, as both tests ultimately test visual-constructive skills. The correlation coefficient is Rho = 0.61 and is significant (p=0.023, even significant after Bonferroni correction). The hypothesis can be supported.

The last hypothesis H6 supposed: There is a significant positive correlation between the test results of the DAPT and the Mosaic Test of the Hamburg Wechsler Intelligence Test for Adults (MT of the HAWIE-R). Unfortunately, for the same reasons as mentioned above, the number of patients tested with the Mosaic Test from the HAWIE-R was even lower with n=8. Although the correlation coefficient is very high at Rho = 0.57 and is significant (p=0.017, even significant after Bonferroni).

Generalizability is limited due to the small sample size; with this restriction the hypothesis can be supported.

Without concrete hypotheses the correlations between all neuropsychological tests were calculated (see Table 3).

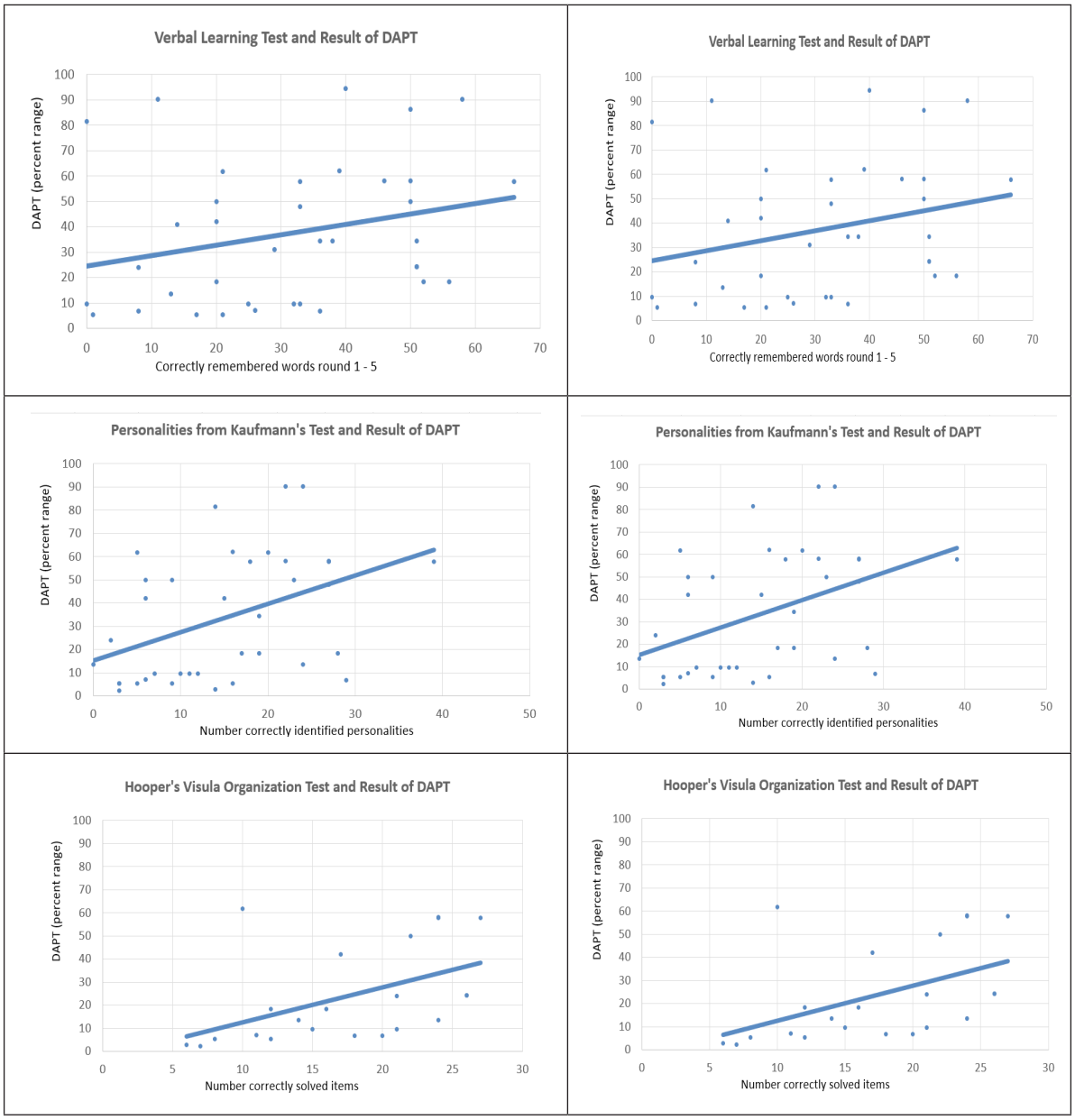

Figure 3: Linear regression lines between the percentile rank of Draw-a-Person test, age and the five tests with a sufficient number of data.

Discussion

The study carried out here was intended to show whether the Draw-a-Person test is suitable to enrich the test battery of existing neuropsychological diagnostic instruments for the objectification of brain damage. The DAPT only requires materials that can be considered available in every clinic (a pen or pencil and a sheet of paper); the DAPT is also a very time-efficient test, most patients needed below 10 minutes.

What could be seen as problematic is that our data came from a field study predominantly on acute patients who have had very different diagnoses; e.g. stroke patients were overrepresented. The diagnostic tests used were not available for every patient or fully available as a data set for the study due to the limitations of being routine tests in daily practice. The tests were selected based on clinical significance and were not modified for the study. In addition, the average age is very high at more than 70 years. However, this is not a disadvantage, the group examined represents the distribution of neurological damage relatively well and the advanced age is also representative, as neurological damage occurs more frequently in old age. Ultimately, the study is about the correlations of the individual test procedures and the points mentioned above are not disadvantageous for correlative calculations. These distributions should therefore not weaken the significance of the use of the DAPT test in clinical practice, as this will apply to exactly the same group of patients. Still, the varying sample sizes are a limitation. Even the total N = 50 is not huge for a validation type study, particularly with a heterogeneous sample. But some of the correlations are limited to only 8 (with Mosaic test) and 12 (with MMSE) participants. Therefore, the results

should not be seen as absolute, but only as a first step to indicate the possibility of supplementing neuropsychological diagnostics with the help of DAPT.

It was expected that a high positive correlation would be found with tests that also measure visual-constructive ability, i.e. primarily from the Mosaic test of the HAWIE-R and the Hoopers Visual Organization Test. It is also reasonable that there was a medium degree of similarity to the results of the MMSE, which also includes a drawing task. What's interesting is that we also found a high correlation with the Number Connection Test, which essentially measures work speed. That the examined person has to draw something, i.e. here a line from one number to the next, is a weak explanation for the high correlation. It was not necessarily expected that the memory tests also showed relatively high correlations. For the Verbal Learning and Memory Test, however, only for the first rounds of learning high correlations were found. The correlation became lower and not significant for long-term retention. On the other hand, there is also a high correlation for the Personalities test, which tests historical memory and declarative memory.

The disadvantage of the test is that not everyone is born with a talent for drawing. Some people simply cannot paint, even if they have not suffered brain damage. Ultimately, one would always have to take the premorbid level into account, but this is usually not possible. On the other hand, it was often the case that when asked to draw a person, patients said that they absolutely couldn't paint, but then made quite decent drawings. The advantage of the draw-a-person test is certainly that the professional investigator can immediately identify a wide range of deficits without any evaluation. For example, patients with hemineglect paint one half of the figure incompletely, while those with visual agnosia have massive problems even drawing a recognizable human figure. Parkinsonism patients often scribble tiny figures on the page. Patients with dementia sometimes forget to draw parts of the human appearance. When interpreting the results of the Draw a Person Test, it is crucial to recognize that outcomes can be influenced by a variety of factors, including individual circumstances and the subjective perspective of the test administrator. These influences can affect the reliability and validity of the test results. Thus, anxiety, depression, or stress may possibly impact drawing performance. Individuals experiencing these emotional states may produce drawings that are less detailed or more disorganized, reflecting their internal distress and affecting their overall test scores.

Also cultural norms and artistic conventions may possibly influence how individuals approach the task. People from different cultural backgrounds may have varying styles and expectations for drawing human figures, which can affect the content and structure of their drawings. Recognizing the potential influences on the Draw a Person Test results and implementing longitudinal follow-up or repeated measures can enhance the understanding of how neurological conditions impact drawing performance over time. This approach provides a more reliable and comprehensive assessment, allowing for better insights into disease progression and the effectiveness of treatments. By addressing individual circumstances and using a standardized, consistent methodology, clinicians and researchers can obtain more accurate and meaningful data, ultimately improving patient care and advancing scientific knowledge. Ultimately, this easy-to-carry procedure definitely enriches neuropsychological testing and many patients - after initial hesitation - actually enjoy the task, which can even relieve them -- like a break -- between other tedious test batteries [28].

The appendix contains 16 drawings by the patients. Even without counting the exact point value, the pictures provide valuable clues. Artistic skills are not necessarily required; most adults can probably create a figure like the one created by patients #8 or #14, for example. The drawing of patient #10, on the other hand, is practically unrecognizable as a human; you can still make out the head and neck, but what is shown to the right and left is left to the imagination. Picture #16 does a little better here, but you have to know that in this case it was the 3rd attempt to draw a human figure and that the patient was very surprised that he just didn't really succeed. The figures of patients #7 and #13 are at least recognizable, although both pictures are missing important details, for example in #7 an eye, a foot and the hands; in #13 the whole face is missing; the juxtaposition of one and two-dimensional representation is interesting here: arms and legs are only represented by a line. Patient #5 initially drew only a stick figure, but then remembered that the test requires a "clothed person" and then drew clothing over the stick figure. What is striking about the picture of patient #6 is the incorrect anatomical positioning of the arms (far too low) and legs (too far out). The pictures of patients #1, #3 and #13 show arms that are far too short; from a psychoanalytic point of view, this can indicate a lack of freedom of action. Although patient #2 has not had an accident, the arms look as if they are bandaged, the fingers are completely missing and the torso is not closed at the bottom. Most of the figures are smiling, which is usually done spontaneously in such drawings. But pictures #1, #4 and #7 have downward-turned corners of the mouth. Although wearing hats is rather unfashionable today, the pictures of patients #5, #6, #7, #13, #14 and #15 have hats; perhaps these patients remember their youth when people still wore hats? Despite severe slowing and significant memory deficits, demented patient #4 achieved a very high score with her very precise drawing; her drawing is of almost artistic value and suggests that she has been painting pictures all her life.

Institutional Review Board Statement

The data for the investigation of the Draw-a-Person test came from a larger project about dementia. Ethic committee Name: Ethik-Kommission der Medical School Hamburg. Approval Code: MSH-2018/57. Approval Date: 15. June 2018. The study was conducted according to the guidelines of the Declaration of Helsinki.

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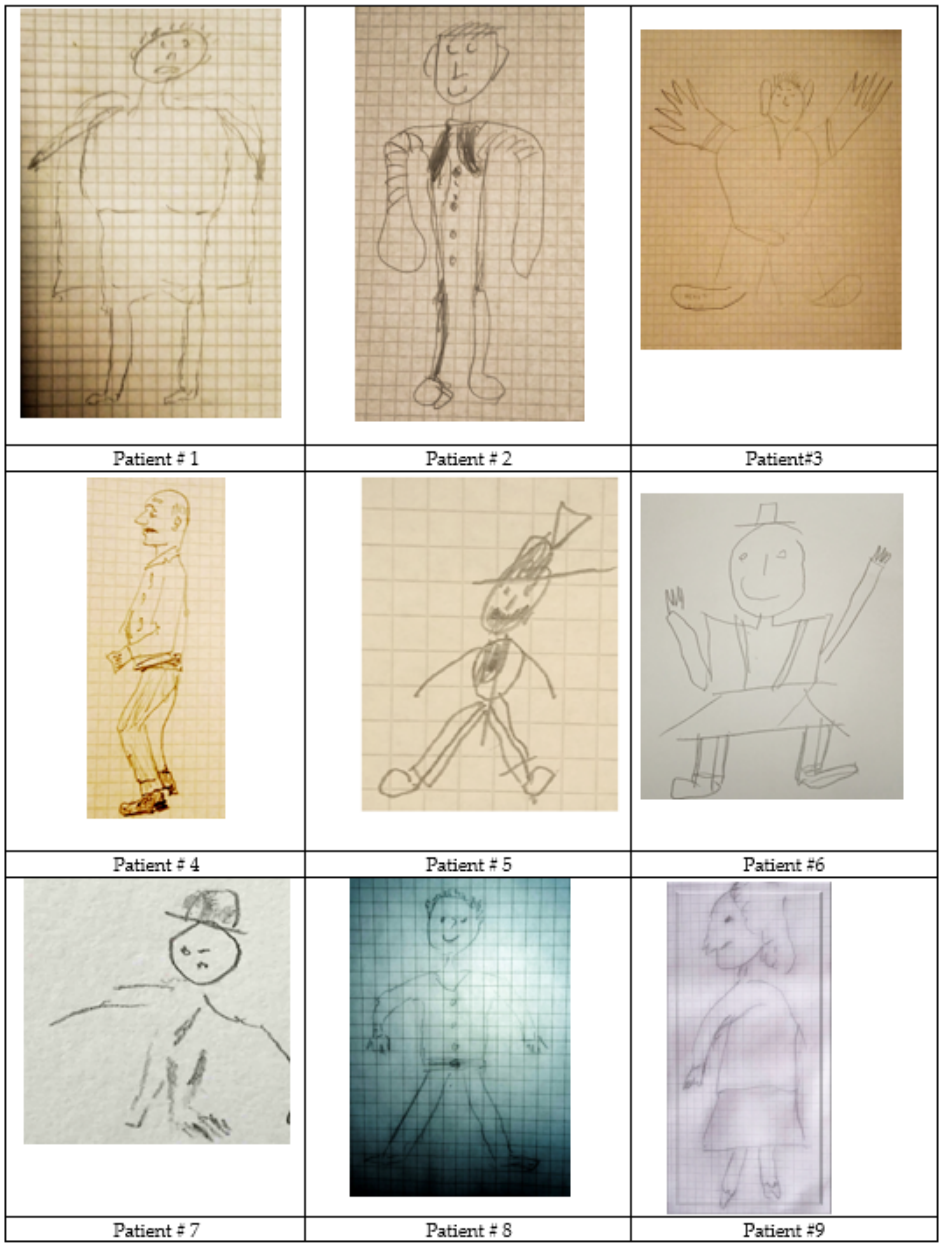
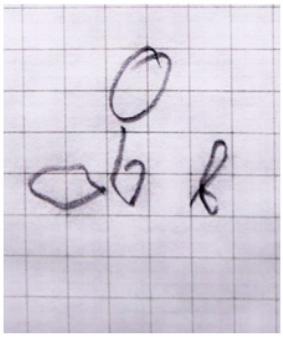
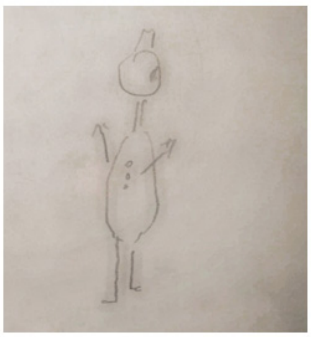
Supplement

Examples of drawings of patients:



		
Patient # 10	Patient # 13	Patient # 14
		
Patient #15	Patient #16	