LURIJA INSTITUT

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Diagnostic Instrument for Limb Apraxia

Short Version (DILA-S)

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1st Edition

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A: Central issue and goals

Currently, strokes are the second most common cause of death worldwide (Murray et al., 2012), although the number of deaths following a stroke has been continuously falling in Germany since 1998 (Busch, Heuschmann & Wiedmann, 2012). Over the age of 40 years, an average of one person in thirty will suffer a stroke, and this probability increases considerably with age (from a lifetime prevalence rate of 0.9 % for 40–49 year olds to 7.1 % for 70–79 year olds; Busch, Schienkiewitz, Nowossadeck & Gößwald, 2013).

Survivors of brain damage due to stroke often continue to face severe functional impairments, including impairments involving language (aphasia) and motor function (hemiplegia). Other impairments – like limb apraxia – are often not detected immediately, and their effects on patients are often underestimated.

Limb apraxia is defined as a disorder of skilled movement, not caused by weakness, akinesia, deafferentiation, abnormal tone or posture, movement disorder (such as tremors or chorea), intellectual deterioration, poor comprehension, or uncooperativeness" (Goldenberg, 2011, p. 1). In most cases, limb apraxia follows left brain damage and co-occurs with aphasia (Goldenberg, 2011). Therefore, the symptoms of limb apraxia often are covered by instruction comprehension and language disabilities. Further, patients also often suffer from hemiplegia. Nevertheless, limb apraxia typically affects both sides of the body, also if the ipsilesional hand is not motorically impaired (Goldenberg, 2011, p.2f.). Because limb apraxia as a higher ordered cognitive-motor disorder should be visible in both hands similarly, the ipsilesional hand is always tested to avoid the influence of motor difficulties on task execution. (Note: Different single cases with lesions in the Corpus Callosum are known.)

Typically, sensitive tests of limb apraxia request the imitation of hand postures and the pantomime of gestures. Though, problems with the execution of real tool use actions with objects can also be part of the symptoms. Such an apraxia of tool use involves a complex cognitive-motor dysfunction when using objects or tools (Goldenberg, 2011), that has not yet received enough attention. Patients with apraxia of tool use select the wrong tools to use with presented objects (e.g. soap instead of toothpaste when using a toothbrush) and/or make a wrong movement with the tool (e.g. brushing hair with a toothbrush) or make no movement at all (Bohlhalter, 2009). For these reasons, apraxia is very relevant for patients' independency in their daily lives. Studies show that patients with apraxia are more often dependent on their caregivers (Poeck, 2006; Wu, Burgard & Radel, 2014), that they are less likely to return to their job (Dovern, Fink & Weiss, 2011; Wang, Kapellusch & Garg, 2014), and that the severity of apraxia can predict the rehabilitation outcome (Dovern et al., 2011; Hanna-Pladdy, Heilman & Foundas, 2003). Despite high prevalence rates of apraxia in 30–50 % of left hemisphere stroke patients (De Renzi, Motti & Nichelli, 1980; Dovern et al., 2011; Dovern, Fink & Weiss, 2012; Vanbellingen, 2013), most clinics do not include tests of apraxia in their standardized diagnostic procedures. There are several reasons for this lack of attention to a highly relevant disorder affecting daily life. Firstly, apraxia has a high comorbidity with hemiparesis and aphasia, which are more easily and frequently detected and dominant in rehabilitation training by therapists, patients, and family members. Secondly, there are few assessments that directly test real tool use. Conventional methods for testing apraxia normally only test the imitation of meaningless and meaningful gestures and the pantomime of tool use. These tests are represented in, for example, the TULIA (test of upper limb apraxia; Vanbellingen, 2012), its short version, the AST (apraxia screen of TULIA; Vanbellingen, 2012, 2013), and the KAS (Kölner Apraxie Screening; Weiss, Kalbe, Kessler & Fink, 2013). Even more recently developed assessments do not test real tool use (e.g. STIMA, short test for ideomotor apraxia; Tessari, Toraldo, Lunardelli, Zadini & Rumiati, 2015),

or just insufficient. For example, the SAST (short apraxia screening test; Leiguarda, Clarens, Amengual, Drucaroff & Hallett, 2014) only tests it with two items and one of these items (the rotation of a coin in the hand) is not a motor-cognitive, but rather a motor-technical task, and does not reflect the true demands of real tool use in daily life.

For this reason, the Diagnostic Instrument for Limb Apraxia (DILA) was formed, combining tasks concerning real tool use with tasks concerning imitation of meaningful and meaningless gestures and pantomime of tool use. The real tool use tasks include tests of novel tools (mechanical problem solving) and familiar tools (the use of familiar objects and their corresponding tools). This detailed testing of various domains of apraxia is necessary to describe the various facets of apraxia of tool use, and to assess difficulties with these different elements. The sub-tests comprising the DILA will therefore be presented and evaluated separately, with distinct cut-off values for the evaluation of difficulties. All of the tasks can be clearly and concisely explained to the patient, with the help of associated pictures or actual objects and tools to further increase understanding. The use of images and objects means that this test can also be used for aphasic patients, who would be unable to understand uniquely verbal instructions.

Since the originally developed DILA is too long for use in a rehabilitation centre, a short version with the most sensitive items was developed (Diagnostic Instrument for Limb Apraxia – Short Version; DILA-S). This short version can be completed in about 30 minutes, and is therefore recommended for clinical use and introduced here. Further, for all sub-tests individual cut-off values are presented, so a unique testing with only some of the sub-tests is possible. If only short time is available for diagnostic approaches we recommend to use the Familiar Tools Test as screening.

The DILA-S can be conducted after extensive examination of the current manual, test items, and evaluation sheets, regardless of the type of qualification of the examiner (e.g. occupational therapist or (neuro-) psychologist). Additionally, it is recommended to test the tasks once with a colleague, to get in touch with the sub-tests. For training, the attached CD with videos of all sub-tests may also be useful. The exemplary evaluations, which can be found at the end of each section match the executions of tasks in the video. In reason of data protection no real patient is shown in the video. Instead, typical errors of patients are re-enacted.

Table 1: Overview of common apraxia tests in Germany, compared to the DILA-S

Authors	Name of instrument	Tested domains	Stimulus	Patient population	Process routes	
					Ventral	Dorsal
Rothi et al., 1984	FAST	I, P	S, G, rO	21 patients, HC	x	–
Power et al., 2010	FABERS	I, P	S, G	16 HC	x	x
Vanbellingen, 2012	TULIA	I, P	S, G	84 LBD, 49 RBD, 50 HC	x	x
Vanbellingen, 2013	AST	I, P	S, G	31 stroke patients	x	x
Weiss et al., 2013	KAS	I, P	Ph	188 LBD, 48 HC	x	x
Leiguarda et al., 2014	SAST	I, P, TU*	S, rO, G	70 LBD, 40 HC	x	x
Tessari et al., 2015	STIMA	I	G	111 HC	x	x
Buchmann & Randerath, 2017	**DILA-S**	**I, P, TU**	**S, rO, Ph, G**	**33 LBD, 20 RBD, 82 HC**	**X**	**X**

Psychometric data

Reliability	Validity	Sensitivity/Specificity	Cut-Off values
–	–	–	x
Interrater: ≥ 89%	–	–	–
Interrater: .65-.99 (kappa) Retest: $\alpha = .83$	good criteria and convergent validity (r = .82)	–	Differentiation between mild, moderate and severe apraxia
Retest tested with the same items from TULIA	discriminant and convergent validity	SE: 95%; SP: 100%	Differentiation between mild and severe apraxia
Interrater: $\rho = .907$ (spearman's rho)	satisfactoring concurrent validity with Goldenberg's imitation test	SE: I: 83.3%, P: 81.5%; SP: I: 100%, P: 98%	x
Interrater: $\rho = .918$ (spearman's rho)	AUC compared with FAST-R: .928	SE: 92%; SP: 79%	x
–	–	–	–
Interrater: $\tau = .577$-1.000; internal consistency: CR ≥. 549 intercorrelations: $\tau \geq .338$	**convergent validity with AST: $\tau = .500$, with KAS: $\tau = .522$; discriminant validity with WCST $\tau \leq .272$, with Neglect $\tau \leq .218$**	–	**domain specific estimation with differentiation between mild, moderate and severe apraxia**

Tetsted domain: I = imitation; P = pantomime; TU = real tool use (* motor-technical task, see p. 5)
Stimulus: G = gestures; Ph = photos of objects; rO = real objects; S= speech
Patient population: HC = healthy controls, LBD = patients with left brain damage due to stroke in the left hemisphere, RBD = patients with right brain damage due to stroke in the right hemisphere
Sensitivity/Specificity: SE = sensitivity, SP = specificity; I = imitation, P = pantomime

B: Structure and Implementation

The following structure for the test session is recommended:

I. Imitation of meaningless gestures (2–5 min)
II. Familiar Tools Test (5–15 min)
III. Pantomime of tool use (8–15 min)
IV. Imitation of meaningful gestures (2–5 min)
V. Novel Tools Test (5–15 min)
VI. NAT Breakfast Task (3–10 min)

The testing with the DILA-S is evaluated with patients with left or right brain damage due to stroke or traumatic brain injury. Patients with severe receptive aphasia or neglect can also be tested with this instrument, but need special consideration measures. These measures are described in detail for the appropriate sub-tests. For patients, which fatigue very fast, not all sub-tests have to be tested at one session. Nevertheless, it is desirable, that no sub-test itself is divided into two session parts.
The person described in the exemplary evaluations is a fictive 45-years old male patient with left hemisphere stroke.

Note: For clarity, the following text is written exclusively using male pronouns. The instructions apply equally to females, and the pronouns used should be adapted in the testing situation.

1. Imitation of meaningless and meaningful gestures:

Background

For patients, the imitation of movements can help them to gain therapeutic improvement in occupational and physical therapy.
It has been hypothesized that there are different routes in which meaningless and meaningful gestures may be processed in the brain, notably by the dorsal and ventral streams. The dorsal stream is based on a path from the occipital cortex to the posterior parietal cortex (Sinclair & Stones, 2008) and is responsible for determining the position of an object (Goldstein, 2008) and processing its structure (Goodale & Milner, 1992). This is the pathway in which meaningless gesture imitation is thought to occur. The "body part coding" hypothesis suggests that in the "imitation of meaningless hand gestures […] body parts and their limitations can be recognized […] and correlated with each other" (Goldenberg, 2009). The meaningless gestures used in this battery were taken from Goldenberg (1996).
The second processing path, the ventral stream, leads from the occipital cortex to the inferior temporal cortex (Sinclair & Stones, 2008) and is thought to identify objects (Goldstein, 2008). Instead of directly imitating the gesture by determining the hand position with the dorsal stream, meaningful gestures can be identified and retrieved from semantic memory (Goldenberg, 2008). Meaningful gestures should convey specific information without additional verbal communication, but cannot normally "be syntactically linked to the production of complex and multi-part messages" (Goldenberg, 2011, p. 31). The meaningful gestures used here include instructions to: "salute", "listen carefully", "plug the nose", "call someone crazy", "swear an oath", "look into the distance", "please be quiet", "think", "yawn" and "blow somebody a kiss". The recognition of gestures was tested with 25 healthy volunteers, who were shown pictures of the gestures. Every meaningless gesture was correctly rated as meaningless by at least 72 % of the participants, and every meaningful gesture was correctly identified by at least 80 % of the participants.

Items

The tests each include 10 items and one practice item. Since the patients recognize different gestures in the meaningful gestures, there are no particularly sensitive items. Therefore, the long tests are used for meaningful and meaningless gesture imitation in both the short and full-length versions of the diagnostic instrument.

Duration

2–5 min each

Materials
Evaluation sheet, pen

Instructions for the therapist
The patient should perform the gestures with his ipsilesional hand, so that hemiparesis in the contralesional hand will not influence the execution of the gesture. The therapist should perform the gestures so that they are mirror-inverted i.e. a patient with left brain damage will perform the gesture with his left hand, so the therapist will demonstrate it with his right hand.
All gestures are held until the patient has found his hand position. If the position of the patients' hand is not correct, the patient is once requested to correct the gesture (see below). If the gesture remains in an incorrect position, the therapist continues with the next gesture. Between the gestures, the patient is asked to put his hand flat on the table.

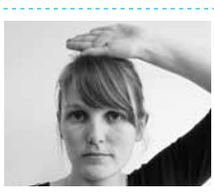
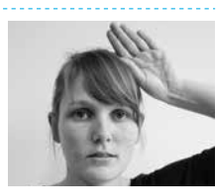
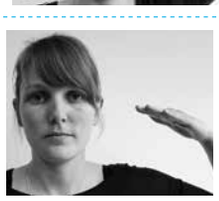
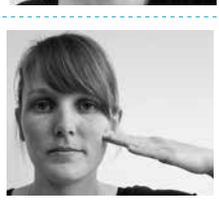
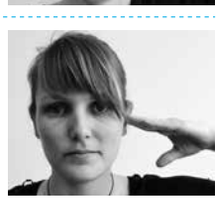
Instructions for the patient
"Please imitate the following gestures with your left/right hand. I will show you the gestures with my right/left hand, so that it is a mirror-inverted image. Pay attention to the position of my hand and the relation of my hand to the body. If you have found the correct position, please hold it. We will start with one practice item. If you have any questions, please do not hesitate to ask them."

– If the first imitation is not correct: **"Unfortunately this was not quite correct. Please look closely and try once more."**
– If the patient asks why this diagnostic test is done with him: **"The imitation of gestures is very important for your occupational and physical therapy. There, the therapists often show you movements, which you should imitate."**

Evaluation and interpretation
There is a three-tier evaluation system, in which the patient is awarded a score of 0–2 (Total Error, Second Correct, First Correct) per item. 2 points (First Correct) are awarded if the patient correctly imitates the gesture in the first attempt (fluent searching movements are allowed). The patient receives 1 point (Second Correct) if the gesture is corrected successfully (including self-correction). If the self-correction is a fluent movement, then 2 points are awarded, but if the initial gesture is held for about 2 seconds and then corrected, 1 point is given. 0 points (Total Error) are awarded if the gesture is not correctly imitated in the first or second attempt. A patient can achieve a maximum of 20 points per subtest. The cut-off values for the determination of apraxia were calculated separately for different age groups. For meaningless gestures, patients between 21–50 years are designated as apraxic if they score less than 16 points. Patients between 51–80 years have a cut-off value of less than 15 points. For meaningful gestures, the cut-off value for patients between 21–50 years is a score of less than 18 points. For patients between 51–80 years, the cut-off value is less than 16 points.

Correct imitation and typical errors
The following pages demonstrate the correct position of each gesture, and the typical errors associated with each. The examples are not exhaustive. For the error examples, the gestures are re-enacted to ensure patient privacy. Additionally, in tables 3 and 5 essential characteristics of each gestures are listed, which have to be shown to get 2 or 1 point(s).

Table 2: Correct imitation and typical errors of meaningless gestures

No.	correct	typical error examples		
0				
1				
2				
3				
4				
5				

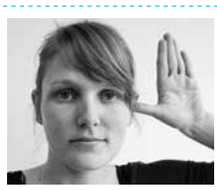
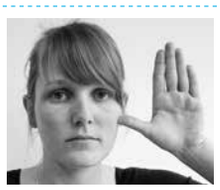
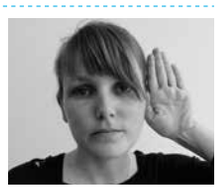
No.	correct	typical error examples		
6				
7				
8				
9				
10				

Table 3: Imitation of meaningless gestures – important points

No.	photo	important points
0		– hold hand in front of the body – closed fist – thumb on the fist, not inside
1		– hand is stretched, fingers together, thumb braced in 90° (take a special look on arthrosis or similar diseases) – thumb under nose, not side by
2		– hand is stretched, fingers together, thumb braced in 90° (take a special look on arthrosis or similar diseases) – thumb on the mouth not touching the nose
3		– hand is stretched, fingers together, thumb fits closely (take a special look on arthrosis or similar diseases) – fingertips under the chin – thumb does not look out
4		– hand is stretched, fingers together, thumb fits closely (take a special look on arthrosis or similar diseases) – hand on the head, not side by or behind the head
5		– hand is stretched, fingers together, thumb fits closely (take a special look on arthrosis or similar diseases) – finger tips at the ear not at the cheek

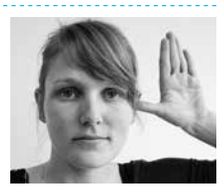
No.	photo	important points
6		– hand is stretched, fingers together, thumb braced in 90° (take a special look on arthrosis or similar diseases) – hand on the head, not side by or behind the head – hand stretched to the top, thumb lies at the head
7		– hand is stretched, fingers together, thumb fits closely (take a special look on arthrosis or similar diseases) – hand knuckles touch the chin from below – thumb does not look out
8		– hand is stretched, fingers together, thumb braced in 90° (take a special look on arthrosis or similar diseases) – thumb touches the ear – fingers show upwards
9		– hand is stretched, fingers together, thumb braced in 90° (take a special look on arthrosis or similar diseases) – hand is hold in front of the chin, fingertips touch the lips – hand is turned that palm shows to the front
10		– hand is stretched, fingers together, thumb fits closely (take a special look on arthrosis or similar diseases) – hand fits closely to the ear and cheek – palm shows outside, hand knuckles to the cheek

Table 4: Correct imitation and typical errors of meaningful gestures

No.	correct	typical error examples	
0			
1			
2			
3			
4			
5			

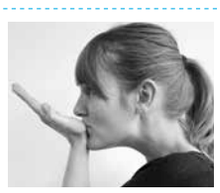
No.	correct	typical error examples	
6			
7			
8			
9			
10			

Table 5: Imitation of meaningful gestures – important points

No.	photo	important points
0		– hold hand in front of the body – closed fist – thumb shows upwards
1		– hand is stretched, fingers together, thumb fits closely (take a special look on arthrosis or similar diseases) – fingers touch the forehead laterally
2		– hand is curved, fingers together, thumb fits closely (take a special look on arthrosis or similar diseases) – hand lies behind the ear – thumb is also behind the ear
3		– hand is an almost closed fist – nose is kept shut with thumb and index finger
4		– hand is an almost closed fist with braced, stretched index finger – index finger touches the forehead laterally ahead (not at the level of the ear)
5		– hand is stretched, fingers together, thumb braced (take a special look on arthrosis or similar diseases) – hand is hold laterally to the body at the level of the shoulders

No.	photo	important points
6		– hand is stretched, fingers together, thumb braced in 90° (take a special look on arthrosis or similar diseases) – hand is hold in front of the forehead, index finger and thumb touch the forehead – thumb lays laterally at the forehead
7		– hand is an almost closed fist with braced, stretched index finger – index finger is hold in front of the mouth and lays on the lips – index finger does not touch the nose – finger knuckles show to the side, not to the front
8		– middle, ring and little finger lay on the chin – index finger is stretched at the cheek – thumb lays from below at the chin
9		– hand is stretched, fingers together, thumb braced or fits closely (take a special look on arthrosis or similar diseases) – hand is hold in front of the mouth so the mouth could not be seen by the therapist – *Mouth opening is not important!*
10		– hand is stretched, fingers together, thumb braced or fits closely (take a special look on arthrosis or similar diseases) – hand is hold flat in front of the mouth with palm showing upwards and fingers towards the therapist – *Kissing mouth is not important!*

Exemplary evaluation

Imitation of meaningless gestures

Name: A. B. Date: 19.03.2016

No.		First Correct 2 points	Second Correct 1 point	Total Error 0 points	No.		First Correct 2 points	Second Correct 1 point	Total Error 0 points
0		do not evaluate			6		X		
1		X			7			X	
2			X		8				X
3		X			9				X
4		X			10				X
5			X		Notes: The patient showed severe difficulties when imitating meaningless gestures.				

Sum: 11 /20

Age	no apraxia	mild apraxia	moderate apraxia	severe apraxia
21–50 year olds	16–20	14–15	13	(0–12)
51–80 year olds	15–20	14	12–13	0–11

Imitation of meaningful gestures

Name: A.B. Date: 19.09.2016

No.		First Correct 2 points	Second Correct 1 point	Total Error 0 points
0		do not evaluate		
1		X		
2			X	
3		X		
4		X		
5		X		

No.		First Correct 2 points	Second Correct 1 point	Total Error 0 points
6				X
7			X	
8				X
9		X		
10			X	

Notes:
The patient was only able to imitate those gestures correctly, which were familiar to him. All other gestures could not be imitated.

Sum: 13 /20

Age	no apraxia	mild apraxia	moderate apraxia	severe apraxia
21–50 year olds	18–20	17	15–16	(0–14)
51–80 year olds	16–20	15	13–14	0–12

2. Familiar Tools and Novel Tools Test

Background

Evaluating the ability of patients to use real objects is a good way of evaluating how apraxia affects their daily lives and routines. Tasks of everyday tool use are therefore more relevant for patients, and provide them with more motivation to complete the tasks.
There is also a difference between the dorsal and ventral routes for this task. Objects and tools used in the Novel Tools Test should be processed via the dorsal route, because they should have no preassigned meaning. For novel tools, "possibilites [of mechanical interaction] can be deduced from visible structural features" (Goldenberg, 2011, p.48). People should therefore be able to solve mechanical problems by infering an object's function from its structure (Goldenberg & Spatt, 2009; Randerath, 2009). This contrasts with the objects of the Familiar Tools Test, which are part of daily life and routine, and can thus be processed by the ventral route. Semantic knowledge can be used to apply a tool to a recipient object. So far, patients have done better in real tool use tasks than in pantomime tasks (Randerath, 2009; Randerath, Goldenberg, Spijkers, Li & Hermsdörfer, 2011), because in real tool use tasks, contextual factors like the range of available tools and objects, or their structures, can be used to help determine the objects' functions. Therefore it is really important to give some tools for selection to the patients.
In a patient group of 33 left hemisphere stroke patients only half of them could achieve selecting the correct tool in first attempt. This suggests that tool selection can differentiate between apraxic and non-apraxic patients.

Items

An item consists of one cylinder (Novel Tools Test) or one recipient object (Familiar Tools Test) and three tools. Both tests had a long version with ten items and one practice item. The here introduced short version consists of the five most sensitive items, with three practice items. At least one practice item is demonstrated for all patients, with the additional two examples available if it is necessary for ensuring task comprehension.
For the Novel Tools Test, five of the eleven items in the long version were taken from Goldenberg and Hagmann (1998), and six more difficult items were added. The short form with the most sensitive items of the sub-test only uses these more difficult items, with three of the Goldenberg and Hagmann (1998) items included as practice items.
For all items an ordering system is introduced to have all items in the right order for testing.

Table 6: Materials for the Familiar Tools Test

objects	tools	objects	tools
plate with noodles	fork	dustpan with snippets	hand brush
pan with fried egg	spatula	wooden board with screw and nut	wrench
shoe	shoe brush		bottle opener
pot filled with water & bowl/soup plate	ladle		tweezers
paper	stapler		chalk
board	sponge		

Duration
5–15 min for each subtest

Materials
Evaluation sheet, pen
Novel Tools (cylinder socket, 8 cylinders, and 8 tools)
Familiar tools (see Table 6)
Ordering system

Instructions for the therapist
The tools and objects are placed like shown in Figure 1 (Familiar Tools) or Figure 2 (Novel Tools). Special attention is paid to first put the objects/cylinders at the table and then the tools. Place the three corresponding tools in front of the object/cylinder so that they are centrally presented in front of the patient. Or in case of neglect it rather should be shifted towards the unaffected side, so the patient is able to perceive all tools and parts of the object. Additionally, the patient is reminded to pay attention to all three tools. For all of the tasks, there is only one correct tool. Although other tools might also work, they will not work as well as the correct tool. The patient should search for the most common (Familiar Tools Test) or safest (Novel Tools Test) variant of using the recipient object/lifting up the cylinder. All of the tasks are solvable with one hand. The patient should solve the problems with his ipsilesional hand, so that contralesional hemiparesis should not influence the execution of the movement. Any supportive functions normally made with the non-dominant hand (e.g. holding the dustpan) are not evaluated in the test, and can be undertaken by the therapist. If the patient hesitates for one minute or more without touching or selecting a tool, the therapist should encourage him again to try a tool.

Additional information for the structure of the **Familiar Tools Test:**
Item 0.1: Favourably, the noodles should be soaked in cold water some minutes before testing, so that it is possible to spear with the fork.
Item 0.2: There are no special provisions necessary.
Item 0.3: The shoe can be hold by the therapist that it does not drop.
Item 1: It is recommended to put the bowl near to the pan, so that no water is spread around the table.
Item 2: To facilitate the use of the stapler with one hand, the papers should be bended at one corner, so that patients can staple the papers at this corner.
Item 3: There should be no written words on the board. Instead, paint an easy recognisable picture on it. So aphasic patients are not uncertain.
Item 4: The dustpan should be hold by the therapist.
Item 5: It is enough if the patient loosens the nut a few times with the wrench. If he wants to dissolve the rest with the hand, it is allowed. But the screw should be tightened in the beginning so far, that it is only possible to loosen it with the wrench and not with hand.

Fig. 1: Familiar Tools – Item 0.2

Fig. 2: Novel Tools – Item 0.1

Additional information for the use of the **Novel Tools: Items 0.1-0.3:** There are no special provisions necessary.
Item 1: The patient should recognize that neither the middle nor the right tool has the appropriate diameter for this cylinder. With the left tool the cylinder is easy to lift up and transport.
Item 2: If the patient tries to pull the tool over the tube of the cylinder but it does not work because the tube moves, the therapist is allowed to help.
Item 3: The rope has to be knot short enough that it is only possible to solve the task with the left tool (and not to use the hook). Please pay special attention that this task is solved unimanually (as all other tasks as well).
Item 4: If the patient tries to solve this task with the middle tool, please advise him to use another tool before he tries to lift up the tool. Otherwise the cylinder falls down in most of the cases.
Item 5: The patients often use the right tool but only pull it over the pyramid without interlock it and then try to lift the cylinder up. This way the cylinder also almost always falls down.

Instructions for the patient
Familiar Tools: **"I will now show you an everyday object** *(show where the object is set up)* **and three tools** *(show three fingers).* **Please select the one tool that is most suitable to use with the object. Take it into your hand, and show how you would apply it. Please actually perform its use one time in the correct manner and not only feint it. If you realize that you have chosen the wrong tool, you can always switch to another tool. We will start with one practice item. If you have any questions, please do not hesitate to ask them."**

Novel Tools: **"I will now show you a cylinder** (show cylinder socket) **and three tools** *(show three fingers and point to the place where you will put each tool).* **Please select the one tool that is most suitable to lift up the cylinder. Please connect the tool to the cylinder, lift the cylinder out of the socket on the table and put the tool back on the table** *(pantomime the movement).* **If you realize that you have chosen the wrong tool, you can always switch to another tool. We will start with one practice item. If you have any questions, please do not hesitate to ask them."**

For severe aphasic patients build up the first practice item without any instructions. Then explain the tasks with this example.
Familiar Tools: **"You are seeing here a plate with noodles and three tools** *(point to the plate and tools).* **With which of these three tools** *(tip each tool after another)* **you can use this object here** *(point to the plate)* **best?"**

Novel Tools: **"You are seeing here a cylinder and three tools** *(point to the cyinder and tools).* **With which of these three tools** *(tip each tool after another)* **you can lift up the cylinder safely** *(take the hand upwards besides the cylinder)***?"**

Familiar Tools:
Never name the actions directly. The action affordances should be known by looking at objects and tools.

For both:
– If the first tool is wrong and the patient does not realize that: **"There is another tool that works better with this object/cylinder."**
– If the first movement is wrong: **"Maybe try another way to use the tool with this object/to lift the cylinder up with this tool."**

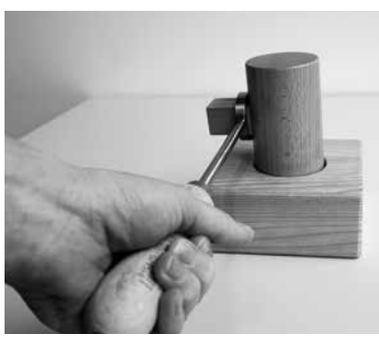
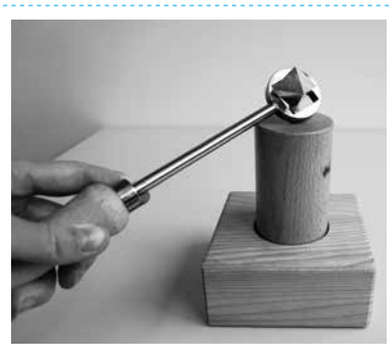
Evaluation and interpretation
There are three evalution scales for the Familiar/Novel Tools. For the Selection Scale, the patient receives 2 points if the first used tool was the correct one (marked with a thick blue frame on the evaluation sheet).

The patient receives 1 point if he self-corrected his selection, or was prompted by the therapist to do so, and chose the correct one in his second attempt.
0 points are awarded if the patient could not find the correct tool (in which case it would be handed to him) or tried the correct tool in his third attempt.
For tool use only the usage of the correct tool is evaluated on a Production and Execution Scale. On the first scale (Production Scale) the detailed parts of the movement with grip-formation (marked with "G" on the evaluation sheet), grip-orientation (thumb-direction on tool-handle; "OT"), movement-content ("M") and movement-orientation ("O") are evaluated. The detailed descriptions of these criteria are listed on the evaluation sheets for each item. If all points for grip-formation, grip-orientation, movement-content, and movement-orientation are met at first attempt, the patient receives 2 points on the Execution Scale and 4 points on the Production Scale. If the patient self-corrected or correctly performed the movement in his second attempt, he receives 1 point on the Execution Scale and 4 points on the Production Scale. If the patient was not able to use the tool properly, or only succeeds after several attempts or with instructions, no points on the Execution Scale are awarded, and the points the patient has achieved on the Production Scale are taken into account, and the patient awards a score between 0–3 points.
However, for Total Error (0 points on the Execution Scale), all correct points on the Production Scale have to be marked.

In the Novel Tools Test some very skillful patients may solve items 3 and 4 with other tools than the marked correct one. If this happens, the selection of the tool is evaluated with 0 points (Total Error), because the patient has not looked for the safest tool. Nevertheless, the use of the tool has to be evaluated with 4 points on the Production Scale and 2 (First Correct) or 1 point (Second Correct) on the Execution Scale.
If the patient cannot solve the item by himself, the therapist is advised to help the patient to finish the task. This procedure supports keeping up the patients' motivation. Of course as soon as the therapist intervenes, the achieved action cannot be regarded as correctly solved by the patient.
There is a maximum score of 10 points for the Selection and Execution Scales and of 20 points for the Production Scale. The cut-off values for apraxia are as follows:
Selection Familiar Tools: 21–50 years: < 9 points, 51–80 years: < 8 points
Production Familiar Tools: < 20 points
Execution Familiar Tools: < 9 points
Selection Novel Tools: < 6 points
Production Novel Tools: Men: < 18 points, Women: < 17 points
Execution Novel Tools: Men: < 7 points, Women: < 5 points

Correct use of Novel Tools

Table 7: Correct use of Novel Tools

No.	correct	No.	correct
0.1		0.2	
0.3		1	
2		3	
4		5	

Exemplary evaluation

Familiar Tools Test

Name: A.B. Date: 19.09.2016

No.	Item	Selection		
0.1	 take pasta from the plate			
0.2	 take a fried egg out of the pan			
0.3	 clean the shoe			
1	 scoop soup from pot to bowl	 1st choice		
2	 staple two pieces of paper			

Selection	Production		Execution	Notes
do not evaluate	G: lateral or pincer grip OT: towards the tines M: spear downwards, transport to the mouth O: downwards towards the pasta, upwards towards the mouth		do not evaluate	
do not evaluate	G: lateral or tight cylinder grip OT: towards the functional part of the spatula M: move towards the fried egg, slide the spatula under the fried egg, take it out O: towards the fried egg, take it out (upwards)		do not evaluate	Patient understood the task
do not evaluate	G: lateral grip OT: points away from the participant M: apply the brush on the shoe, repetitive movement circular or stroking O: towards the shoe		do not evaluate	not executed
☐ **2** ☒ **1** ☐ **0**	G: lateral or pincer grip OT: towards the functional part of the ladle M: scoop*, transport, pour out*, * = rotation of the forearm/wrist O: downwards to pot, sideways to the bowl	① ① ① ① 	☐ **2** ☒ **1** ☐ **0**	
☒ **2** ☐ **1** ☐ **0**	G: lateral or cylindrical grip OT: towards the functional part of the stapler M: slide the paper between top and bottom of stapler, push downwards, remove stapler from the paper O: forwards towards the paper, remove from the paper	① ① ① ① 	☐ **2** ☒ **1** ☐ **0**	

G = grip-formation, **OT** = grip-orientation, **M** = movement-content, **O** = movement-orientation Selection & Execution: **2** = First Correct; **1** = Second Correct; **0** = Total Error

Familiar Tools Test (Continuation)

Name: A.B. Date: 19.09.2016

No.	Item	Selection		
3	 wipe the board			
4	 sweep the garbage onto the dust-pan		 1st choice	
5	 loosen a screw			

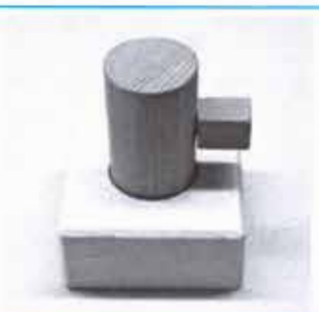
Selection	Production		Execution	Notes
☒ **2** ☐ **1** ☐ **0**	G: wide cylinder grip OT: points away from the participant M: apply to the board, repetitive movement of rotation or stroking O: towards the board	① ① ① ①	☒ **2** ☐ **1** ☐ **0**	
☐ **2** ☒ **1** ☐ **0**	G: tight cylinder or lateral grip OT: towards the functional part of the brush M: repetitive movement towards the dust-pan, movement coming from the elbow O: hand brush sideways towards the dust-pan	① ① ① ①	☒ **2** ☐ **1** ☐ **0**	
☐ **2** ☒ **1** ☐ **0**	G: tight cylinder or lateral grip OT: towards the functional part M: dock the wrench to the screw, repetitive movement parallel to the board in one direction, loosen the srew O: parallel to the board towards the screw	① ① 1 1	☐ **2** ☐ **1** ☒ **0**	
7		18	6	**Sum**
y 9–10 o 8–10		20	9–10	**no apraxia**
y 8 o 7		19	8	**mild apraxia**
y (7) o 6		(18)	(6–7)	**moderate apraxia**
y 0–6 o 0–5		0–17	0–5	**severe apraxia**

The patient often needed 2 attempts to apply the tools correctly.
The selection was also difficult for him.

y = 21–50 year olds, o = 51–80 year olds

Novel Tools Test

Name: A.B. Date: 19.09.2016

No.	Item	Selection		
0.1				
0.2				
0.3				
1				
2				

Selection	Production		Execution	Notes
do not evaluate	G: cylinder or lateral grip OT: towards the functional part of the tool M: forward towards the cylinder, position the tool, lift up, transport O: functional part of the tool underneath the T of the cylinder		do not evaluate	Patient understood the task
do not evaluate	G: cylinder or lateral grip OT: towards the functional part of the tool M: sideways towards the cylinder, place functional part of tool around rod, lift up, transport O: functional part of the tool over the rod		do not evaluate	not executed
do not evaluate	G: cylinder or lateral grip OT: towards the functional part of the tool M: sideways towards the cylinder, place functional part onto square, lift up, transport O: functional part onto square		do not evaluate	- " -
☒ **2** ☐ **1** ☐ **0**	G: cylinder or lateral grip OT: towards the functional part of the tool M: forward towards the cylinder, place the tool, lift up, transport O: functional part of the tool positioned below the pyramid	(1) (1) (1) (1)	☒ **2** ☐ **1** ☐ **0**	
☐ **2** ☒ **1** ☐ **0**	G: cylinder or lateral grip OT: towards the functional part of the tool M: forward, put the functional part of the tool over the tube, jam/fold the tube, lift up, transport O: put the functional part of the tool over the tube	(1) (1) (1) (1)	☐ **2** ☒ **1** ☐ **0**	

G = Grip, **OT** = Orientation of the Thumb, **M** = Movement, **O** = Orientation

Selection & Execution: **2** = First Correct; **1** = Second Correct; **0** = Total Error

Novel Tools Test (Continuation)

Name: A.B. Date: 13.03.2016

No.	Item	Selection		
3			 1st choice	
4				
5			 1st choice	

Selection	Production		Execution	Notes
☐ **2** ☒ **1** ☐ **0**	G: cylinder or lateral grip OT: towards the functional part of the tool M: forwards, put the functional part of the tool first into one loop, then into the other one, lift up, transport O: put the functional part of the tool into loops	(1) (1) 1 1	☐ **2** ☐ **1** ☒ **0**	The patient only captured the rope on one end and lifted it up without the cylinder.
☒ **2** ☐ **1** ☐ **0**	G: cylinder or lateral grip OT: towards the functional part of the tool M: forwards, sideways to the cylinder, place functional part of the tool over tube and move towards solid part, lift up, transport O: functional part of the tool over/around the tube and solid part of the cylinder	(1) (1) (1) (1)	☒ **2** ☐ **1** ☐ **0**	
☐ **2** ☒ **1** ☐ **0**	G: cylinder or lateral grip OT: towards the functional part of the tool M: forwards, put functional part of the tool over pyramid and turn/interlock, lift up, transport O: functional part of the tool over the pyramid	(1) (1) 1 (1)	☐ **2** ☐ **1** ☒ **0**	
7		17	5	**Sum**

(6–10)		m	18–20	m	7–10	**no apraxia**
		f	17–20	f	5–10	
5		m	(17)	m	6	**mild apraxia**
		f	16	f	4	
4		m	16	m	(5)	**moderate apraxia**
		f	15	f	0–3	
0–3		m	0–15	m	0–4	**severe apraxia**
		f	0–14	f	*	

The patient was able to select the right tools, but was not able to use them correctly in many cases.

m = male, f = female, * = no further distinction possible

3. Pantomime of tool use

Background

In pantomime tests, people are requested to show an action with an object without taking the object in their hand (Goldenberg, 2011). Aphasic patients could use this pantomime to replace missing words, and thereby to communicate more effectively (Goldenberg, 2008). It is important for this task to include both the features of use of the object and the features of the object itself: knowledge and sense of the typical movement made with the object are needed (Randerath, 2009). In order to make a correct grip, manipulation knowledge of the object is essential, and to make a correct movement, the patient needs to combine "the successful retrieval of the matching movement representation and [its] integration into a movement plan" (Randerath, 2009, p. 47). A frequent error is that people use parts of their hands to represent the tool itself. For example, when pantomiming a stamp, people often beat the table with their fist. Errors of this type are called body-part-as-object (BPO) errors. This is not specific for patients with apraxia; it is a regular step in childhood development (Goldenberg, 2013b), but healthy persons tend to make less errors (Duffy & Duffy, 1989; Haaland & Flaherty, 1984; McDonald, Tate & Rigby, 1994; Raymer, Maher, Foundas, Heilman & Rothi, 1997) and correct them when prompted (Raymer et al., 1997). When first making the pantomime, older healthy people are more likely to make BPO errors than younger people, but the groups do not differ when requested to correct the pantomime (Peigneux & van der Linden, 1999).
For the construction of this sub-test, half of the test items chosen are BPO-vulnerable and half are not. An item is considered BPO-vulnerable if more than one healthy person from a group of 82 volunteers made a BPO error.

Items

The long version of the test consists of 14 items, half of which are BPO-vulnerable.
The short version of the test contains 8 items, again with half of them being BPO-vulnerable. For this verison, the BPO-vulnerable items are hammer, pencil, binoculars, and scissors. The non-BPO-vulnerable items are iron, lightbulb, key, and spoon. Further, there are three practice items, of which at least one example item should be performed for each patient. The two additional practice items can be demonstrated if the patient has not understood the task immediately.

Duration

8–15 min

Materials

evaluation sheet, pen
booklet with photos of the items

Instructions for the therapist

Pantomimes have to be executed with the ipsilesional hand, so that hemiparesis in the contralesional hand will not influence the results. Any supportive functions, which are usually made with the non-dominant hand – for example, holding the wine bottle while using a corkscrew – are not considered in the evaluation of the movement because they can be influenced by motor disabilities due to hemiparesis.
Provide the verbal and visual information to the patient at the same time: the therapist starts by saying *"Show me how to …"* and then should simultaneously show the picture as saying the rest of the sentence (e.g. *"… hit a nail with a hammer").* It is important to present the photos centrally in front of the patient. Or in case of neglect it rather should be shifted towards the unaffected side, so the patient is able to perceive all important features of the object on the photo. Subsequently, the patient should perform each movement twice to allow the therapist to make an accurate evaluation.
At the beginning all patients should perform the first practice item. If the patient understands the task immediately, the test items can follow. If the patient does show a wrong or no movement at the first practice trial, the therapist can lead the patients' hand to the correct

movement. Subsequently, the practice trials have to be done so task comprehension is ensured.

Instructions for the patient
"I will show you photos of some objects. Please show me with your left/right hand the typical movement you would make if you were holding the object in your hand. I will also name the typical movements. Please show me every movement twice. We will start with a practice item. If you have any questions, please do not hesitate to ask them."

– if the first attempt is not correct: **"Please make sure you are pretending to hold *the object*** *(replace by the concrete object, e.g. "the hammer")* **in your hand."**

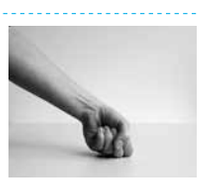
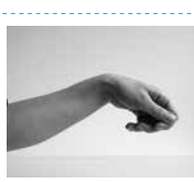
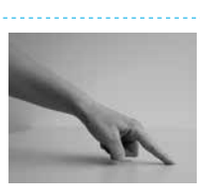
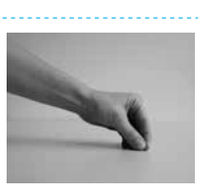
Evaluation and interpretation
There are two evaluation scales for this task. On the Production Scale the movement parts grip-formation (marked with "G" on the evaluation sheet), movement-content ("M") and movement-orientation ("O") are rated. The detailed criteria of each item are shown on the evaluation sheet. Further, the Execution Scale with the 3 point-Scale is evaluted (0–2 points; Total Error, Second Correct, First Correct). 2 points (First Correct) are given if grip-formation, movement-content, and movement-orientation were correct at the first attempt. 1 point (Second Correct) is awarded if the patient corrected the movement by self-initiated correction or correction on request. If the person made a BPO-error and corrected it, he receives 1 point in the Execution Scale, and a "yes" in the column of BPO-errors. The patient gets 0 points (Total Error) if the grip-formation, movement-content, and/or movement-orientation was/were not correct. Perseverations, non-corrections of false pantomimes or Body-part-as-Object-Errors as well as omitted movements are all evaluated as erroneous pantomimes. However, for Total Error (0 points on the Execution Scale), all correct points on the Production Scale have to be marked.

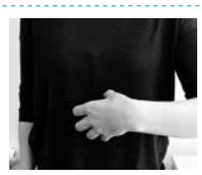
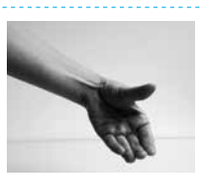
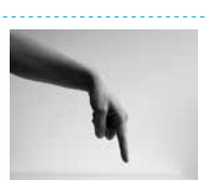
This results in a maximum score of 24 points on the Production Scale and of 16 points on the Execution Scale. The cut-off values for apraxia are scores of less than 22 points on the Production Scale and less than 12 points on the Execution Scale.

Further, BPO-errors are shown separately. For items, which are vulnerable for BPO-errors, the "yes" on the evaluation sheet is written in bold letters and respectively the "no" is written in bold letters for items which are not vulnerable. Clear apraxic deficits are shown if the patient is not able to correct his BPO-errors.

Error examples

Table 8: BPO- and typical error examples in the hand configuration when pantomiming tool use

No.	Item	BPO-error	common errors in hand configuration	
0.1	**fork**	 using index finger as fork	 cylindrical instead of lateral grip	 grip too wide open
0.2	**screwdriver**	 index finger used as screwdriver	 grip too tightly closed	 grip in wrong orientation and size
0.3	**saw**	 hand used as saw	 hand not at sagital level	 grip shows in wrong direction
1	**hammer**	 fist used as hammer	 movement comes from the wrist	 grip too wide open
2	**pencil**	 index finger used as pencil	 missing distance to the table	 writing in the air
3	**iron**	 hand used as iron	 missing distance to the table	 cylindrical grip too wide open

No.	Item	BPO-error	common errors in hand configuration	
4	**binoculars**			
		hand(s) used as binoculars	missing distance to the eye	hand too wide open
5	**bulb**			
		fist used as bulb	wide cylindrical instead of spherical grip	orientation to the body
6	**scissors**			
		index and middle finger used as scissors	all fingers in the scissor (instead of only index and middle finger)	no forward movement of the hand
7	**key**			
		index finger used as key	grip too wide open	cylindrical instead of lateral grip
8	**spoon**			
		index finger used as spoon	rotating movement from the ellbow	cylindrical instead of pincer grip

Exemplary evaluation

Pantomime of tool use

Name: A.B. Date: 15.09.2016

Instruction: "Show me …"

No.	Pantomime	Grip and movement	Production	Execution	BPO
0.1	how to eat with a fork	G: pincer grip or tight lateral grip M: from table to mouth O: fingers directed to the mouth without touching it	do not evaluate The patient had to imitate	do not evaluate	yes/**no**
0.2	how to open a wine bottle with a corksrew	G: cylinder grip M: repeated rotating movement from the wrist O: hand pointing downwards	do not evaluate	do not evaluate	yes/**no**
0.3	how to saw with a saw	G: tight cylinder grip with arm in vertical position M: repetitive, big amplitude movement O: sagittal level	do not evaluate	do not evaluate	yes/**no**
1	how to hit a nail with a hammer	G: tight cylinder or lateral grip M: up and down movement from the elbow O: movement has to stop before touching the table	1 1 1	☒ **2** ☐ **1** ☐ **0**	**yes**/no
2	how to write with a pencil	G: pincer grip M: repetitive small amplitude movement parallel to the table O: distance of the fingers from the table	1 1 1	☐ **2** ☒ **1** ☐ **0**	**yes**/no
3	how to iron with a flat iron	G: tight cylinder grip with pronated arm (hand pointing downwards, thumb to the body) M: big amplitude movement parallel to the table O: distance from the table	1 1 1	☒ **2** ☐ **1** ☐ **0**	yes/**no**
4	how to look through binoculars	G: wide cylinder grip, back of the hand hand points outwards, distance between thumb and index finger M: movement towards the eyes O: distance to the eyes	1 1 1	☐ **2** ☐ **1** ☒ **0**	**yes**/no

G = grip-formation, **M** = movement-content, **O** = movement-orientation

No.	Pantomime	Grip and movement	Production	Execution	BPO
5	how to screw in a light bulb	G: spherical grip (room for bulb) M: repetitive rotation of the forearm around the longitudinal axis O: hand pointing away from the body	1 1 1	☐ 2 ☐ 1 ☒ 0	yes/(no)
6	how to cut paper with scissors	G: fingers angled with opposition of the thumb M: opening and closing movement vertical to the table O: forward movement of the hand	1 1 1	☐ 2 ☒ 1 ☐ 0	(yes)/no
7	how to open a lock with a key	G: lateral grip M: rotation of the forearm around the longitudinal axis O: sagittal forward	1 1 1	☒ 2 ☐ 1 ☐ 0	yes/(no)
8	how to stir the coffee with a spoon	G: pincer grip showing downwards M: repeated rotating movement from the wrist O: distance to the table	1 1 1	☐ 2 ☒ 1 ☐ 0	yes/(no)
		Sum	22	9	
		no apraxia	(22–24)	12–16	
		mild apraxia	20–21	10–11	
		moderate apraxia	15–19	(7–9)	
		severe apraxia	0–14	0–6	

Number of BPO-errors: 2 corrected: 1

(There are no further evaluation scales for BPO use, because the use of BPO is taken into account in the Execution and Production Scale. The frequency of a BPO strategy provides information about the presence of this special error-type. Please note that there are items that are prone to BPO use even in healthy adults as indicated by a bold "yes" in the BPO column. Healthy adults correct these errors in second try so it is pathological if the patient is not able to correct his BPO error. And there are items for which BPO use is rather pathological as indicated by a bold "no" in the BPO column.)

Notes:
The patient had moderate difficulties to execute the pantomimes immediately. In second attempt he mostly was able to show the correct pantomime.

4. ADDITIONALLY: NAT Breakfast Task

Background

This task can additionally be executed and serves as a standardised version of a daily life action. Typical errors and the omission of steps, like shown downwards, could also be seen in group settings, but then can not be compared to the here presented norm data.
This task is originally taken from Schwartz, Segal, Veramonti, Ferraro and Buxbaum (2002) "Naturalistic Action Test – Breakfast Task". "A naturalistic action refers to learned movement sequences, which are normally performed with familiar objects to achieve a higher goal" (Schwartz et al., 2002, p. 312). In such tasks, not only the use of known tools is essential, but also keeping the task in mind, executive functions for monitoring the task, separating it into consecutive steps, and executing these steps carefully (Goldenberg, 2008, 2011, 2013a; Schwartz, Buxbaum, Veramonti, Ferraro & Segal, 2001). Various single step actions must therefore be arranged into a chain of actions that pursues an overall goal (Goldenberg, 2008). Consequently, this task can be complicated not only by apraxia-errors in the use of individual tools – but also by a lack of systematic strategies, or a lack of understanding of the task due to aphasia (Goldenberg, 2008).

Duration

3–10 min

Materials

Evaluation sheet, pen
Booklet with photos of the final products (finished slice of toast and tea)
Toaster, kettle filled with water
Wooden board or plate, 1 knife, 1 tea spoon, 1 table spoon, 1 cup
Sugar, butter or margarine, teabags in a container, toast, jam
double plug, extension cable
All food should be stored in the fridge and surveyed on deterioration before usage.

Instructions for the therapist

Place all of the materials on the table in front of the patient as shown in Fig. 3. The board/plate is placed directly in front of the patient, with the jam, toast, cup, and teabags on the left side, and the toaster, kettle, butter or margarine, sugar, knife, and spoons on the right side (see figure 3). It is recommended to use a kettle that has an adjustable temperature setting, and that the temperature be pre-set to 40 °C. It is also recommended that the kettle and toaster be plugged into a multiple socket that has an emergency stop. Typical errors that might result in such an emergency situation are listed below. Assistance is allowed if the patient is having difficulties due to lack of strength or mobility but has made an afford to start the particular action. If the patient is doing something dangerous (e.g. putting fingers in the toaster), the therapist should immediately cancel the action.
If the patient does not start any meaningful action in the first three minutes, the task should be ended.

Fig. 3: Set-up of the NAT Breakfast Task

Instructions for the patient
"I would like you to do the following two things (*showing two fingers):* **Please prepare one slice of toasted bread with butter/margarine and jam** *(show the photo of the toast)* **and a cup of tea with sugar** *(show the photo of the tea).* **Everything you need for this task is located in front of you. I will help you if necessary, but you must start all actions on your own."**

– if the patient does not start: **"Please begin with the task."**
– if the patient is unsure e.g. because of Neglect: **"I cannot tell you how to solve this task. Everything you need is placed in front of you. Make sure to look to your left/right."**
– After one minute without any attempts: **"Please remember, the task was preparing breakfast consisting of a slice of toasted bread with butter/margarine and jam, and a cup of tea with sugar."**

Evaluation and interpretation
For this task, four different scales are adapted from Schwartz et al. (2002). The first is the "Lateralized Attention Score" (LAS), which indicates which objects were attented to. For this scale, it is not important whether the materials were used but it is important on which materials attention was paid to.
The LAS is obtained from the subtraction of the ipsilesional proportion from the contralesional proportion. This provides information about the impact of neglect on the performance of the task. The ideal value – when all materials are noticed – is 0.
The second scale is the "Accomplishment Score" (AS), which measures which parts of the task were performed. The AS is calculated from the addition of all completed steps for a maximum score of 7.
Subsequently, the "Error Score" (ES) is evaluated, which measures how many errors were made while completing the task. This score results from the addition of both apraxic errors (such as spreading the butter with a finger instead of a knife) and non-apraxic erros (such as omissions like forgetting to stir the tea). The minimum score of 0 is optimal, a maximal score of 19 errors can be achieved. All errors can be marked on the evaluation sheet.
Finally, the "Naturalistic Action Task Score" (NAT Score) is derived from a combination of the AS and ES (see table 9).

Table 9: Calculation of the Naturalistic Action Task Score from Accomplishment Score and Error Score

Accomplishment Score	Error Score	Naturalistic Action Task Score
7	0–1	6
7	> 1	5
6	0–1	4
6	> 1	3
4–5	0–1	2
4–5	> 1	1
0–3		0

The maximum NAT Score is 6 points. As in Schwartz et al. (2002) the cut-off value of < 4 points, corresponding to the cut-off values of 6 points in AS and 0–1 errors in ES has been replicated in the actual norm data sample.

Error examples

For error examples readjusted photos are shown to ensure patient privacy.

Table 10: Typical errors in the NAT Breakfast Task

Item	typical errors		
spread butter and jam with knife			
correct use of knife and spoon			
put toast in the toaster			

Exemplary evaluation

NAT Breakfast Task

Name: A.B. Date: 19.09.2016

Set-up:

Evaluation:

Left		Right	
toast (minimum 6 slices)	✓	toaster	✓
jam with loosened screw cap	✓	butter/margarine	✓
cup	✓	1 knife	✓
teabags in a carton	✓	1 table spoon	
		1 tea spoon	
		kettle filled with water	✓
		sugar in container	
	4/4		4/7

Lateralized attention score = contralesional (right) – ipsilesional (left) proportion: 0,57 - 1 = -0,43

Notes:
The patient attended the right side only after repetitive request

Accomplishment Score:

Toast:

- ☒ toasted bread (1)
- ☐ apply butter *or* jam to the bread (1)
- ☒ apply butter *and* jam to the bread (2) 3/3

Tea:

- ☐ switch on the kettle (1)
- ☒ put the teabag in the cup (1)
- ☒ infuse water (1)
- ☐ add sugar (1) 2/4

Sum: 5/7

Error Score: Number:

- toasts more than one slice of bread: 1
- mixes up the order: 1
  - ☐ fill in water then plug in the kettle
  - ☐ infuse water, then turn on the kettle
  - ☐ turn on the toaster without bread inside
  - ☐ butter the bread first and then put it in the toaster
  - ☐ apply jam to bread and then butter it
  - ☒ omit to stir the tea
  - ☐ omit to spread the butter and/or jam 1
- use one ingredient extremely excessive or sparsely: 0
- typical errors of apraxia:
  - ☐ spread with the finger
  - ☐ spread with the spoon
  - ☐ put the bread on top of the toaster
  - ☐ press the bread with the hand in the toaster
  - ☐ take butter with the spoon (for jam ok!)
  - ☐ take sugar with the knife
  - ☐ empty the sugar directly in the cup
  - ☐ put jam in the cup
  - ☐ put sugar on the bread
  - ☐ put the teabag on the bread

Error Score = Sum of errors: 3 /19

NAT Score:

Accomplishment Score	Error Score	Naturalistic Action Task Score	Interpretation
7	0–1	**6**	**no apraxia**
7	>1	**5**	
6	0–1	**4**	
6	>1	**3**	**mild apraxia**
4–5	0–1	**2**	**moderate apraxia**
4–5	>1	(1)	**severe apraxia**
0–3	≥0	**0**	

The patient is not able to execute all single step tasks. Further, he forgot the precise instructions very fast.

C: Psychometric data

1. Normative data

There are four common ways to calculate cut-off values. The first approach is to take the median value. This approach would not be appropriate in this case, because it would mean that 50 % of the control group would also be diagnosed as apraxic. The next possibility is to determine the cut-off values by using the mean, minus one or two standard deviations. However, this is unsuitable because the mean in ordinal scaled tasks – like the ones which are introduced here – is not robust against outliers (Sedlmeier & Renkewitz, 2008). Similarly, using the value of the minimum would also be strongly influenced by outliers. The remaining method – using the lowest 5th percentile as a cut-off value – is the most appropriate, and the method used here. For the normative sample, 82 healthy volunteers – adults between 21–80 years old – were recruited. Conditions for inclusion were right-handedness, no neurological or psychiatric illnesses (including addictions, but excluding tobacco), German as their native language or at an equal level of fluency, and a minimum of 13 age corrected points in DemTect (Pantel, 2009). The subjects were subdivided by age into 6 groups (21–30, 31–40, 41–50, 51–60, 61–70, and 71–80 years), each containing twelve to sixteen participants. Since only two age groups are differentiated in calculations – 21–50 and 51–80 year olds – this division was maintained for the determinations of cut-off values. Of the 82 subjects, 62 % were female, half had completed professional training, and the other half had completed a university degree. Half of the subjects completed the tasks with only their left hand, and the other half with only their right hand.
The cut-off values for all sub-tests were calculated with these data. The cut-off values of the sub-tests of the DILA-S are shown in the tables below. When necessary, differences are made between sex (female vs. male) and/or age groups (21–50 vs. 51–80 year olds).

Table 11: Statistical parameters and cut-off values for the Imitation of meaningless and meaningful gestures

	Age	Imitation of meaningless gestures	Imitation of meaningful gestures
Maximum		20	20
Mean	21–50	19.14	19.48
	51–80	18.45	18.70
Exact significance (2-sided; Mann-Whitney-U)		.013	.001
Median	21–50	19	20
	51–80	19	19
Standard deviation	21–50	1.03	0.77
	51–80	1.40	1.24
5th percentile	21–50	16.15	18
	51–80	15.05	16
Cut-off value	**21–50**	**16**	**18**
	51–80	**15**	**16**

Table 12: Statistical parameters and cut-off values for the Familiar Tools Test

	Age	Familiar Tools Selection	Familiar Tools Production	Familiar Tools Execution
Maximum		10	20	10
Mean	21–50	9.90	19.98	9.90
	51–80	9.48		
Exact significance (2-sided; Mann-Whitney-U)		.001		
Median	21–50	10	20	10
	51–80	10		
Standard deviation	21–50	0.30	0.22	0.37
	51–80	0.72		
5th percentile	21–50	9	20	9
	51–80	8		
Cut-off value	**21–50**	**9**	**20**	**9**
	51–80	**8**		

Table 13: Statistical parameters and cut-off values for the Novel Tools Test

	Sex	Novel Tools Selection	Novel Tools Production	Novel Tools Execution
Maximum		10	20	10
Mean	Women	7.74	19.31	7.86
	Men		19.74	8.94
Exact significance (2-sided; Mann-Whitney-U)			.028	.000
Median	Women	8	20	8
	Men		20	9
Standard deviation	Women	1.29	0.92	1.34
	Men		0.51	1.00
5th percentile	Women	6	17.60	5.60
	Men		18.60	7
Cut-off value	**Women**	**6**	**17**	**5**
	Men		**18**	**7**

Table 14: Statistical parameters and cut-off values for the Pantomime of tool use

	Pantomime Production	Pantomime Execution
Maximum	24	16
Mean	23.56	14.93
Median	24	15
Standard deviation	0.65	1.16
5th percentile	22	12.15
Cut-Off value	**22**	**12**

Table 15: Statistical parameters and cut-off values for the NAT Breakfast Task

	Accomplishment Score	Error Score	NAT Score
Maximum (AS, NAT)/ Minimum (ES)	7	0	6
Mean	6.85	0.52	5.66
Median	7	0	6
Standard deviation	0.39	0.63	0.79
5th percentile	6	0	4
Cut-off value	**6**	**0–1**	**4**

Table 16: Cut-off values for mild, moderate and severe apraxia

Degree	Age	Imitation of meaningless gestures	Imitation of meaningful gestures
no apraxia	21–50	16–20	18–20
	51–80	15–20	16–20
mild apraxia	21–50	14–15	17
	51–80	14	15
moderate apraxia	21–50	13	15–16
	51–80	12–13	13–14
severe apraxia	21–50	0–12	0–14
	51–80	0–11	0–12

Degree	Age	Familiar Tools Selection	Familiar Tools Production	Familiar Tools Execution
no apraxia	21–50	9–10	20	9–10
	51–80	8–10		
mild apraxia	21–50	8	19	8
	51–80	7		
moderate apraxia	21–50	7	18	6–7
	51–80	6		
severe apraxia	21–50	0–6	0–17	0–5
	51–80	0–5		

Degree	Pantomime Production	Pantomime Execution
no apraxia	22–24	12–16
mild apraxia	20–21	10–11
moderate apraxia	15–19	7–9
severe apraxia	0–14	0–6

Degree	NAT Score
no apraxia	4–6
mild apraxia	3
moderate apraxia	2
severe apraxia	0–1

Degree	Sex	Novel Tools Selection	Novel Tools Production	Novel Tools Execution
no apraxia	male	6–10	18–20	7–10
	female		17–20	5–10
mild apraxia	male	5	17	6
	female		16	4
moderate apraxia	male	4	16	5
	female		15	0–3
severe apraxia	male	0–3	0–15	0–4
	female		0–14	*

* = no further distinction possible

2. Patient Data

53 stroke patients of the Kliniken Schmieder Allensbach (Germany) took part in the patient study. Patients were left or right brain damaged due to stroke verified by CT or MRI scan. All patients were right-handed and had no further neurological or psychiatric diseases. Table 17 lists the most important clinical data of these patients.

3. Reliability

Interrater reliability was calculated for all tasks in a healthy normative sample of 15 people, and a patient sample of 10 left brain damaged stroke patients.
For healthy controls, a correlation was not analyzed because of missing variance in data, instead only percent of agreement is reported. The mean agreement in the subtests exceeded 95 % (Imitation of meaningful gestures: 93 %, Imitation of meaningless gestures: 97 %, Pantomime of tool use: 93 %, Familiar Tools Test: 98 % and Novel Tools Test: 95 %). For stroke patients, the interrater reliability was determined with Kendall's Tau. The detailed values are shown in table 18. Overall, substantial to high interrater agreement could be achieved.
The internal consistency of the different scales is also good or very good (Bortz, 1999), with values of CR (Composite Reliability) = .772 for the Imitation of meaningless gestures, CR = .549 for the Imitation of meaningful gestures, CR ≥ .884 for the Pantomime of tool use, CR ≥ .768 for the Familiar Tools Test, and CR ≥ .742 for the Novel Tools Test.

4. Validity

The content validity of the DILA-S compared to the long version was calculated with Kendal's Tau and is very high for all of the sub-tests. The values are: $\tau \geq .634$ ($p = .000$) for Pantomime of tool use, $\tau \geq .471$ ($p = .001$) for the Familiar Tools Test, and $\tau \geq .535$ ($p = .000$) for the Novel Tools Test. No content validity could be determined for the Imitation of meaningful and meaningless gestures and for the NAT Breakfast Task, because no sensitive items could be selected for these tests, and therefore the long versions are used.
Additionally, the external validity was determined with the Apraxia Screen of TULIA (AST; Vanbellingen, 2012, 2013) and the Kölner Apraxie Screening (KAS; Weiss, Kalbe, Kessler & Finke, 2013). Because AST and KAS are only measuring Imitation and Pantomime, for the comparison with the DILA-S also the here used Imitation and Pantomime tasks were used. For calculations including the AST, our score was computed as follows: (Imitation Meaningful + Imitation Meaningless + Pantomime Execution)/3. For calculations including the KAS our data was summarized as follows: (Imitation Meaningful + Imitation Meaningless + Pantomime Production)/3. The correlations between AST and DILA-S as well as between KAS and DILA-S were satisfactory (DILA-S & AST: $\tau = .500$, $p = .000$; DILA-S & KAS: $\tau = .522$, $p = .010$).
Intercorrelations between the sub-tests of the DILA-S were sufficient. The Imitation and Pantomime tasks correlated significantly with each other ($\tau \geq .393$, $p \leq .003$). Further, the real tool use scales (Familiar and Novel Tools Test) correlated significantly with Pantomime of tool use ($\tau \geq .309$, $p \leq .025$) and with each other ($\tau \geq .338$, $p \leq .014$).

5. Further Psychometric Data

Practicability

The practicability in clinical daily life was tested in the Schmieder Kliniken Allensbach by occupational therapists. The therapists were working in early stage (German Phase B) as well as later stage (German Phase C and D) rehabilitation in two groups of therapists. From both groups, six detailed questionnaires and a lot of verbal feedback were helping to improve the present manual and test practicability. With the help of these suggestions, the manual, instructions for patients and evaluation sheets were revised completely. Furthermore, six occupational therapists gave their estimation of the DILA-S on the AKZEPT-Questionnaire (Kersting, 2008). The DILA-S received the overall grade "good" (Mean = 1.83 on German school grades scale). Detailed descriptions are shown in Table 19.

Acceptance of the DILA-S through patients and norm sample

46 persons of the norm sample (HC) and 26 patients with left brain damage due to stroke (LBD) as well as 17 patients with right brain damage due to stroke (RBD) also filled out the AKZEPT-L-Questionnaire by Kersting (2008). This questionnaire asked for the estimated reliability and validity of the DILA-S (scales measuring quality and face validity) as well as their well-being while being tested (scales measuring controllability and incrimination). All participants evaluated the DILA-S as "good" (HC: M = 1.65, LBD: M = 2.04, RBD: M = 1.91 on German school grades scale). Detailed data on the specific scales are shown in table 20.

Table 17: Clinial and demographical data of patients

Group	**LBD** **N = 33**	**RBD** **N = 20**
Sex: male/female	17/16	9/11
Age (mean, range)	60.45 (30-79)	59.00 (27-78)
Days since stroke onset (mean, range)	98.12 (21-784)	56.05 (23-102)
Aphasia:		
No/	11	14
Broca (mild/moderate/severe)	22 (6/5/11)	6 (6/0/0)
Wernicke (mild/moderate/severe)	20 (9/3/8)	1 (1/0/0)

Table 18: Interrater reliability for patients with left hemisphere stroke

Task	Scale	Kendall's Tau (τ)	Significance (p)
Imitation meaningless		0.750	0.003
Imitation meaningful		0.836	0.002
Pantomime	Production	0.753	0.004
	Execution	0.828	0.001
Novel Tools	Selection	0.577	0.038
	Production	0.735	0.012
	Execution	0.786	0.004
Familiar Tools	Selection	0.965	0.002
	Production	1.000	
	Execution	0.912	0.002
NAT Breakfast Task		0.973	0.000

Table 19: Mean judgement of occupational therapists (N = 6) on the DILA-S

Scale	Mean judgement (Min = 1 "does not apply", Max = 6 "does apply completely")
Measure quality (e.g. "With the test differences regarding the tested feature (limb apraxia) can be shown accurately.")	M = 4.50 ("does apply considerably")
Face validity (e.g. "The tasks reflect cognitivemotor requirements which are also necessary in daily life.")	M = 4.50 ("does apply considerably")
Controllability (e.g. "The test instructions were clear and comprehensible.")	M = 4.29 ("does apply rather")
Workload (e.g. "When instructing the tasks I was overstrained.")	M = 2.08 ("does not apply rather")

Table 20: Mean judgement (Min. = 1 “does not apply”, Max. = 6 “does apply completely”) of healthy persons (HC: N = 26) and patients (LBD: N = 26, RBD: N = 17)

Scale	Mean judgement HC	Mean judgement LBD	Mean judgement RBD
Measure quality (e.g. “With this test differences between persons can be measured accurately.”)	M = 4.85 (“does apply considerably”)	M = 4.68 (“does apply considerably”)	M = 4.90 (“does apply considerably”)
Face validity (e.g. “The tasks reflect tasks of daily life activities.”)	M = 5.27 (“does apply considerably”)	M = 5.00 (“does apply considerably”)	M = 5.02 (“does apply considerably”)
Controllability (e.g. “The tasks were clear and comprehensible.”)	M = 5.35 (“does apply considerably”)	M = 5.22 (“does apply considerably”)	M = 5.62 (“does apply”)
Workload (e.g. “I was overstrained by the tasks.”)	M = 0.39 (“does not apply”)	M = 0.74 (“does not apply rather”)	M = 0.99 (“does not apply rather”)

D: References

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E: Evaluation sheets

In the appendix, all evaluation sheets of the subtests are presented. The following order for test execution is recommended:

I. Imitation of meaningless gestures (2–5 min)
II. Familiar Tools Test (5–15 min)
III. Pantomime of tool use (8–15 min)
IV. Imitation of meaningful gestures (2–5 min)
V. Novel Tools Test (5–15 min)
VI. NAT Breakfast Task (3–10 min)

Imitation of meaningless gestures

Name: _____ Date: _____

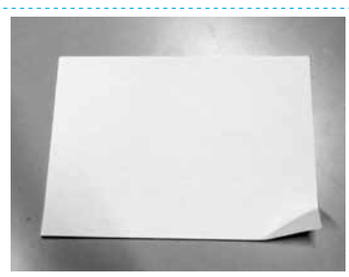
No.		First Correct 2 points	Second Correct 1 point	Total Error 0 points	No.		First Correct 2 points	Second Correct 1 point	Total Error 0 points
0		do not evaluate			6				
1					7				
2					8				
3					9				
4					10				
5					Notes:				

Sum: _____ /20

Age	no apraxia	mild apraxia	moderate apraxia	severe apraxia
21–50 year olds	16–20	14–15	13	0–12
51–80 year olds	15–20	14	12–13	0–11

Familiar Tools Test

Name: _____ Date: _____

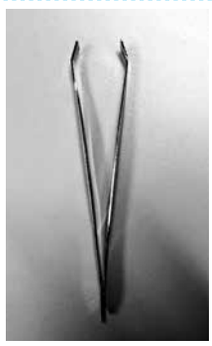
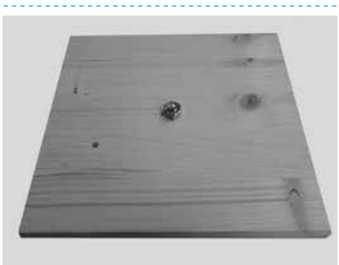
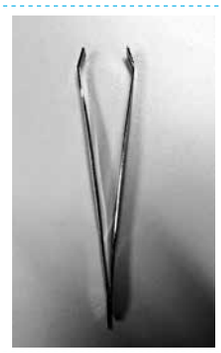
No.	Item	Selection		
0.1	 take pasta from the plate			
0.2	 take a fried egg out of the pan			
0.3	 clean the shoe			
1	 scoop soup from pot to bowl			
2	 staple two pieces of paper			

Selection	Production		Execution	Notes
do not evaluate	G: lateral or pincer grip OT: towards the tines M: spear downwards, transport to the mouth O: downwards towards the pasta, upwards towards the mouth		do not evaluate	
do not evaluate	G: lateral or tight cylinder grip OT: towards the functional part of the spatula M: move towards the fried egg, slide the spatula under the fried egg, take it out O: towards the fried egg, take it out (upwards)		do not evaluate	
do not evaluate	G: lateral grip OT: points away from the participant M: apply the brush on the shoe, repetitive movement circular or stroking O: towards the shoe		do not evaluate	
☐ **2** ☐ **1** ☐ **0**	G: lateral or pincer grip OT: towards the functional part of the ladle M: scoop*, transport, pour out*, * = rotation of the forearm/wrist O: downwards to pot, sideways to the bowl	1 1 1 1	☐ **2** ☐ **1** ☐ **0**	
☐ **2** ☐ **1** ☐ **0**	G: lateral or cylindrical grip OT: towards the functional part of the stapler M: slide the paper between top and bottom of stapler, push downwards, remove stapler from the paper O: forwards towards the paper, remove from the paper	1 1 1 1	☐ **2** ☐ **1** ☐ **0**	

G = grip-formation, **OT** = grip-orientation, **M** = movement-content, **O** = movement-orientation Selection & Execution: **2** = First Correct; **1** = Second Correct; **0** = Total Error

Familiar Tools Test (Continuation)

Name: _____ Date: _____

No.	Item	Selection		
3	 wipe the board			
4	 sweep the garbage onto the dust-pan			
5	 loosen a screw			

Selection	Production		Execution	Notes
☐ **2** ☐ **1** ☐ **0**	G: wide cylinder grip OT: points away from the participant M: apply to the board, repetitive movement of rotation or stroking O: towards the board	1 1 1 1	☐ **2** ☐ **1** ☐ **0**	
☐ **2** ☐ **1** ☐ **0**	G: tight cylinder or lateral grip OT: towards the functional part of the brush M: repetitive movement towards the dust-pan, movement coming from the elbow O: hand brush sideways towards the dust-pan	1 1 1 1	☐ **2** ☐ **1** ☐ **0**	
☐ **2** ☐ **1** ☐ **0**	G: tight cylinder or lateral grip OT: towards the functional part M: dock the wrench to the screw, repetitive movement parallel to the board in one direction, loosen the srew O: parallel to the board towards the screw	1 1 1 1	☐ **2** ☐ **1** ☐ **0**	
				Sum
y 9–10 o 8–10		20	9–10	**no apraxia**
y 8 o 7		19	8	**mild apraxia**
y 7 o 6		18	6–7	**moderate apraxia**
y 0–6 o 0–5		0–17	0–5	**severe apraxia**

y = 21–50 year olds, o = 51–80 year olds

+ use

Name: _____ Date: _____

Instruction: "Show me …"

No.	Pantomime	Grip and movement	Production	Execution	BPO
0.1	how to eat with a fork	G: pincer grip or tight lateral grip M: from table to mouth O: fingers directed to the mouth without touching it	do not evaluate	do not evaluate	yes/**no**
0.2	how to open a wine bottle with a corksrew	G: cylinder grip M: repeated rotating movement from the wrist O: hand pointing downwards	do not evaluate	do not evaluate	yes/**no**
0.3	how to saw with a saw	G: tight cylinder grip with arm in vertical position M: repetitive, big amplitude movement O: sagittal level	do not evaluate	do not evaluate	yes/**no**
1	how to hit a nail with a hammer	G: tight cylinder or lateral grip M: up and down movement from the elbow O: movement has to stop before touching the table	**1** **1** **1**	☐ **2** ☐ **1** ☐ **0**	**yes**/no
2	how to write with a pencil	G: pincer grip M: repetitive small amplitude movement parallel to the table O: distance of the fingers from the table	**1** **1** **1**	☐ **2** ☐ **1** ☐ **0**	**yes**/no
3	how to iron with a flat iron	G: tight cylinder grip with pronated arm (hand pointing downwards, thumb to the body) M: big amplitude movement parallel to the table O: distance from the table	**1** **1** **1**	☐ **2** ☐ **1** ☐ **0**	yes/**no**
4	how to look through binoculars	G: wide cylinder grip, back of the hand hand points outwards, distance between thumb and index finger M: movement towards the eyes O: distance to the eyes	**1** **1** **1**	☐ **2** ☐ **1** ☐ **0**	**yes**/no

G = grip-formation, **M** = movement-content, **O** = movement-orientation

No.	Pantomime	Grip and movement	Production	Execution	BPO
5	how to screw in a light bulb	G: spherical grip (room for bulb) M: repetitive rotation of the forearm around the longitudinal axis O: hand pointing away from the body	**1** **1** **1**	☐ **2** ☐ **1** ☐ **0**	yes/**no**
6	how to cut paper with scissors	G: fingers angled with opposition of the thumb M: opening and closing movement vertical to the table O: forward movement of the hand	**1** **1** **1**	☐ **2** ☐ **1** ☐ **0**	**yes**/no
7	how to open a lock with a key	G: lateral grip M: rotation of the forearm around the longitudinal axis O: sagittal forward	**1** **1** **1**	☐ **2** ☐ **1** ☐ **0**	yes/**no**
8	how to stir the coffee with a spoon	G: pincer grip showing downwards M: repeated rotating movement from the wrist O: distance to the table	**1** **1** **1**	☐ **2** ☐ **1** ☐ **0**	yes/**no**
		Sum			
		no apraxia	22–24	12–16	
		mild apraxia	20–21	10–11	
		moderate apraxia	15–19	7–9	
		severe apraxia	0–14	0–6	

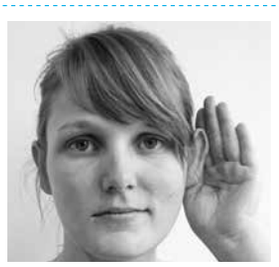
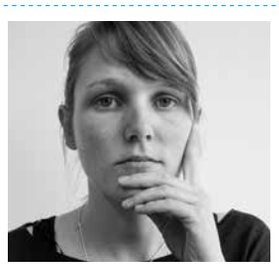
Number of BPO-errors: _____ corrected: _____

(There are no further evaluation scales for BPO use, because the use of BPO is taken into account in the Execution and Production Scale. The frequency of a BPO strategy provides information about the presence of this special error-type. Please note that there are items that are prone to BPO use even in healthy adults as indicated by a bold “yes” in the BPO column. Healthy adults correct these errors in second try so it is pathological if the patient is not able to correct his BPO error. And there are items for which BPO use is rather pathological as indicated by a bold “no” in the BPO column.)

Notes:

Imitation of meaningful gestures

Name: _____ Date: _____

No.		First Correct 2 points	Second Correct 1 point	Total Error 0 points	No.		First Correct 2 points	Second Correct 1 point	Total Error 0 points
0		do not evaluate			6				
1					7				
2					8				
3					9				
4					10				
5					Notes:				

Sum: _____ /20

Age	no apraxia	mild apraxia	moderate apraxia	severe apraxia
21–50 year olds	18–20	17	15–16	0–14
51–80 year olds	16–20	15	13–14	0–12

Novel Tools Test

Name: _____ Date: _____

No.	Item	Selection		
0.1				
0.2				
0.3				
1				
2				

Selection	Production		Execution	Notes
do not evaluate	G: cylinder or lateral grip OT: towards the functional part of the tool M: forward towards the cylinder, position the tool, lift up, transport O: functional part of the tool underneath the T of the cylinder		do not evaluate	
do not evaluate	G: cylinder or lateral grip OT: towards the functional part of the tool M: sideways towards the cylinder, place functional part of tool around rod, lift up, transport O: functional part of the tool over the rod		do not evaluate	
do not evaluate	G: cylinder or lateral grip OT: towards the functional part of the tool M: sideways towards the cylinder, place functional part onto square, lift up, transport O: functional part onto square		do not evaluate	
☐ **2** ☐ **1** ☐ **0**	G: cylinder or lateral grip OT: towards the functional part of the tool M: forward towards the cylinder, place the tool, lift up, transport O: functional part of the tool positioned below the pyramid	1 1 1 1	☐ **2** ☐ **1** ☐ **0**	
☐ **2** ☐ **1** ☐ **0**	G: cylinder or lateral grip OT: towards the functional part of the tool M: forward, put the functional part of the tool over the tube, jam/fold the tube, lift up, transport O: put the functional part of the tool over the tube	1 1 1 1	☐ **2** ☐ **1** ☐ **0**	

G = grip-formation, **OT** = grip-orientation, **M** = movement-content, **O** = movement-orientation Selection & Execution: **2** = First Correct; **1** = Second Correct; **0** = Total Error

Novel Tools Test (Continuation)

Name: _____ Date: _____

No.	Item	Selection		
3				
4				
5				

Selection	Production		Execution	Notes
☐ **2** ☐ **1** ☐ **0**	G: cylinder or lateral grip OT: towards the functional part of the tool M: forwards, put the functional part of the tool first into one loop, then into the other one, lift up, transport O: put the functional part of the tool into loops	1 1 1 1	☐ **2** ☐ **1** ☐ **0**	
☐ **2** ☐ **1** ☐ **0**	G: cylinder or lateral grip OT: towards the functional part of the tool M: forwards, sideways to the cylinder, place functional part of the tool over tube and move towards solid part, lift up, transport O: functional part of the tool over/around the tube and solid part of the cylinder	1 1 1 1	☐ **2** ☐ **1** ☐ **0**	
☐ **2** ☐ **1** ☐ **0**	G: cylinder or lateral grip OT: towards the functional part of the tool M: forwards, put functional part of the tool over pyramid and turn/interlock, lift up, transport O: functional part of the tool over the pyramid	1 1 1 1	☐ **2** ☐ **1** ☐ **0**	

						Sum
6–10		m	18–20	m	7–10	**no apraxia**
		f	17–20	f	5–10	
5		m	17	m	6	**mild apraxia**
		f	16	f	4	
4		m	16	m	5	**moderate apraxia**
		f	15	f	0–3	
0–3		m	0–15	m	0–4	**severe apraxia**
		f	0–14	f	*	

m = male, f = female, * = no further distinction possible

NAT Breakfast Task

Name: _____ Date: _____

Set-up:

Evaluation:

Left		**Right**	
toast (minimum 6 slices)		toaster	
jam with loosened screw cap		butter/margarine	
cup		1 knife	
teabags in a carton		1 table spoon	
		1 tea spoon	
		kettle filled with water	
		sugar in container	
	/4		/7

Lateralized attention score = contralesional – ipsilesional proportion: _____

Notes:

_____

_____

_____

Accomplishment Score:

Toast:

☐ toasted bread (1)

☐ apply butter *or* jam to the bread (1)

☐ apply butter *and* jam to the bread (2) **/3**

Tea:

☐ switch on the kettle (1)

☐ put the teabag in the cup (1)

☐ infuse water (1)

☐ add sugar (1) **/4**

Sum: **/7**

Error Score: Number:

- toasts more than one slice of bread: _____
- mixes up the order: _____
  - ☐ fill in water then plug in the kettle
  - ☐ infuse water, then turn on the kettle
  - ☐ turn on the toaster without bread inside
  - ☐ butter the bread first and then put it in the toaster
  - ☐ apply jam to bread and then butter it
  - ☐ omit to stir the tea
  - ☐ omit to spread the butter and/or jam _____
- use one ingredient extremely excessive or sparsely: _____
- typical errors of apraxia:
  - ☐ spread with the finger
  - ☐ spread with the spoon
  - ☐ put the bread on top of the toaster
  - ☐ press the bread with the hand in the toaster
  - ☐ take butter with the spoon (for jam ok!)
  - ☐ take sugar with the knife
  - ☐ empty the sugar directly in the cup
  - ☐ put jam in the cup
  - ☐ put sugar on the bread
  - ☐ put the teabag on the bread

Error Score = Sum of errors: /19

NAT Score:

Accomplishment Score	Error Score	Naturalistic Action Task Score	Interpretation
7	0–1	**6**	**no apraxia**
7	> 1	**5**	
6	0–1	**4**	
6	> 1	**3**	**mild apraxia**
4–5	0–1	**2**	**moderate apraxia**
4–5	> 1	**1**	**severe apraxia**
0–3	≥ 0	**0**	

Space for own notes

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Diagnostic Instrument for Limb Apraxia – Short Version (DILA-S)

The DILA-S is a new diagnostic instrument to examine limb apraxia. With the help of the classical tests imitation of hand gestures and pantomime of tool use, limb apraxia can be diagnosed. Further, in this instrument tasks for the real use of unknown and familiar tools are established. Hereby, the influence of limb apraxia on daily life activities of the patients can be better represented and diagnosed. With the help of 82 healthy participants, norm data for the subtests were achieved, so that different subtypes of limb apraxia can be verified.

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