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Naturalistic Action Therapy

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A: Central issue and goals

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, S.1). Limb Apraxia leads to difficulties in imitating gestures, pantomiming tool-use and actually using real tools (Goldenberg, 2013). Despite its negative impact on independence in daily life activities (Goldenberg et al., 2001; Goldenberg & Hagmann, 1998; Unsal-Delialioglu et al., 2008) and rehabilitation success (Dovern et al., 2012; Hanna-Pladdy et al., 2003; Wu et al., 2014), studies on the effectiveness of apraxia rehabilitation are scarce (Buxbaum et al., 2008; Buxbaum & Randerath, 2018; Cantagallo et al., 2012; Dovern et al., 2012; van Heugten & Geusgens, 2017; Worthington, 2016). One major problem is that to date only few rehabilitation studies focus on limb apraxia affecting real tool-use. Further, Buxbaum et al. (2008) and Worthington (2016) noted in their reviews on limb apraxia therapy, that published training studies used no or poorly evaluated diagnostic instruments (i.e. instruments not proofed for reliability and validity) to assess initial performance and training outcome. In addition, Buxbaum et al. (2008) criticized in their review that the published training approaches frequently neglected significant points: (a) object recognition tasks were typically not performed, (b) changes in performance in standard apraxia tests were only rarely evaluated, (c) the analysis of maintenance and generalization of training effects was not standard practice, (d) the training was adapted to the individual’s difficulties and thereby not following standardized procedures, (e) often the methods used in training were not reported in sufficient detail, making a replication of results impossible and (f) trainings did not control for spontaneous recovery although patients were usually trained in the subacute phase of illness.

Moreover, none of the trainings reported to date included training of self-evaluation to address a possible related anosognosia. However, anosognosia has been reported to potentially co-occur with limb apraxia (Buchmann et al., 2018; Kusch et al., 2018). Further, performance of apraxic patients seems to benefit when monitoring their errors (Morady & Humphreys, 2009).

We aimed to develop an apraxia rehabilitation method which considers the above described criteria. At the same time the developed approach makes use of general principles known to be effective for neurorehabilitation (e.g. shaping).
The *Naturalistic Action Therapy* approach was designed to train patients with impaired real tool-use and related anosognosia.
With this manual we intend to enhance transperency by detailling the developed training approach.
Please note that thus far only one Phase 1 case-study has been assessed. Further studies on effectivity of this training and refinement of procedural recommendations still need to follow.

B: Structure and implementation

1. Conditions

The *Naturalistic Action Therapy* was developed with patients suffering from major left brain damage due to stroke(s). It consists of several object-interaction tasks. Patients with hemiparesis, severe receptive aphasia or neglect can also be trained with this therapy form. However, patients need to understand simple task instructions.
The single tasks can be implemented separately. This enables to offer the training to patients who additionally suffer from low resilience or severe fatigue.

In this manual, we will describe example tasks of the *Naturalistic Action Therapy* tested in our laboratory, but the therapy concept can – and is anticipated to – be adapted for miscellaneous tasks of daily living, the concerned patient is not able to do by himself.

Note: For simplicity reasons, the following text is written exclusively using male pronouns. The instructions apply to all gender forms, and the pronouns used should be adapted respectively in the training and testing situation.

2. Material

- photo of the action outcome (for each trained task)
- photos of relevant material (for each trained task; one object/tool per photo)
- photos of every task step (for each trained task)
- relevant material for each task (the same as shown on photos)
- cupboard or container with separate space/drawers for the material of each task
- semantic and optic distractors to in-crease the difficulty level of object/tool selection
- smiley scale to evaluate each step

3. Implementation

Patients should be at least moderately impaired in using tools and objects of daily life. This can be assessed by using the *Familiar Tools Test* of the *Diagnostic Instrument of Limb Apraxia – Short Version* (Buchmann & Randerath, 2017; Randerath et al., 2017). Patients and therapists should be motivated to perservere a regular and intensive training. It is recommended to train patients at least for four weeks for about one hour daily.

When considering what to train, those tasks should be prioritized that are very relevant to the patients' life but difficult for him to perform. E.g., if the patient often writes letters, this task may be more important to him than to other persons who e.g. instead may be more engaged in planting flowers. Another criterion is to avoid overstraining. This needs to be determined per individual patient. To provide a rough benchmark we suggest that the trained tasks should be completed within one hour per day .

To circumvent training order effects, the task which was trained last in the previous session should be the first one to be trained in the next session.

The main principles of the *Naturalistic Action Therapy* are *shaping* and *errorless learning*, which means that task difficulty is adapted and increased according to the patients performance level and actions are corrected by the therapist as soon asan error is discovered.

Selection of material

Per default drawers only include materials belonging to one specific task. To further amplify similarity to daily life environments, the complexity should be stepwise enhanced for the selection process (shaping).

1. In the first step, distractor tools with semantic or visual similarity are included in the drawers. Semantic distractors should be semantically related to the task, e.g. stickers for the task “prepare a letter to send”. Optic distractors should look similar but have no semantic relation, e.g. a yellow paper without notes for the task “prepare a letter to send” (Please see section 4 for an example).
2. In a second step the materials of all tasks are completely mixed up and distributed in the entire cupboard.

As soon as the patient manages to perform a score of 100% three times in a row for the whole task including material selection as well as task action, the consecutive level should be introduced in the respective task (shaping).

SUPPORT: If needed, the patient is given help in selecting the correct material following this sequence:

1. Verbal cue: If the patient is looking for the correct material for a long time or opens/closes drawers without aim, the experimenter names the needed objects and tools.
2. Visual cue: If the verbal cue does not help, the experimenter shows the patient photos of the correct material.
3. Selection made by the experimenter: If the visual cue does not help either, the experimenter opens the drawer/ points towards the spot with the correct material and puts it onto the table.

Task performance

Patients are required to perform the task as soon as all relevant material is on the table. Subsequently they are asked to tidy up (i.e. put all materials back into the drawer).

SUPPORT: If needed, help is provided in every single step of a task in a defined manner:

1. Specification of action outcome: If the patient is not able to start an action by himself, the examiner first shows the photo of the final product.
2. Verbal instruction of the next step: If the cue with the final product does not help the patient, the examiner explains verbally what to do next.
3. Specification of interim outcomes: If verbal instruction does not suffice, a photo of the actual interim goal is shown to the patient.
4. Correct movement demonstrated by experimenter: If visual and verbal cues do not succeed, then the participant is asked to imitate the correct movement shown by the experimenter.
5. Movement guided by experimenter: If all these cues do not help the patient in performing the task, the examiner guides the movement of the patients´ arm and hand.

If necessary, these supportive measures are provided for all parts in the same order including material selection, action production and tidying up the materials of the requested action.

Evaluation of task performance

After completing each task, the patient should be asked how well he was able to solve the task in order to enhance his sensitivity for difficult and easy steps of a task. To do so, the smiley scale (see appendix) is shown to the patient. Now, the patient has to evaluate each step of his own performance in this task by using the interim outcome photos. After each self-evaluation, the experimenter provides his evaluation of the patients´ performance. This step is considered to be very important for patients misestimating their own performance, e.g.

tending towards underestimation or overestimation (e.g. anosognosia). Further, it enhances the sensitivity of the examiner (e.g. relative or occupational therapist) for the type of errors made and steps for which the patient needs help, but also for successful parts.

Evaluation is given on a four-point visual-analogue scale:

0 = no difficulties with this step
1 = few difficulties with this step
2 = serious difficulties with this step
3 = impossible to plan and execute the shown step of the task

4. Example

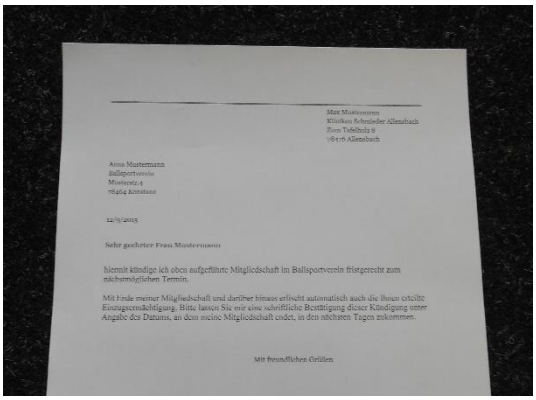
To illustrate the procedure in more detail, the task “prepare a letter to send” is described here exemplary.

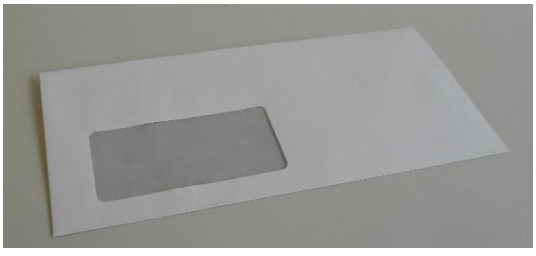
To watch an illustration of one therapy session you can find an example video on https://www.moco.uni-konstanz.de/publikationen/assessments/.

First, the upcoming task is verbalized: “Please prepare a letter to send. All material necessary is in one of these drawers” while showing the photo of the action outcome and pointing towards the cupboard.

Action Outcome:

Material:





Second, all task material should be selected.

Support # 1: If the patient is not able to do so, he is then verbally cued: “Please look for the letter, envelope and stamps.”

Support # 2: If this cue does not help, the experimenter shows the photos of the letter, envelope and stamps.

Support # 3: If this cue does not help, the experimenter opens the correct drawer and puts the needed material on top of the table.

Third, in order to fit the letter into the envelope the patient should fold the letter two times. If the patient is not able to produce the action, help is given via

Support # 1: showing the action outcome photo (see first photo above),

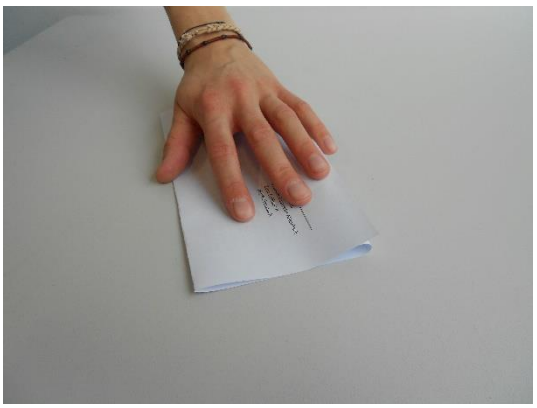
Support # 2: verbal cues (e.g., “You have to fold the letter twice.”),

Support # 3: interim outcome photos (see photos on the right),

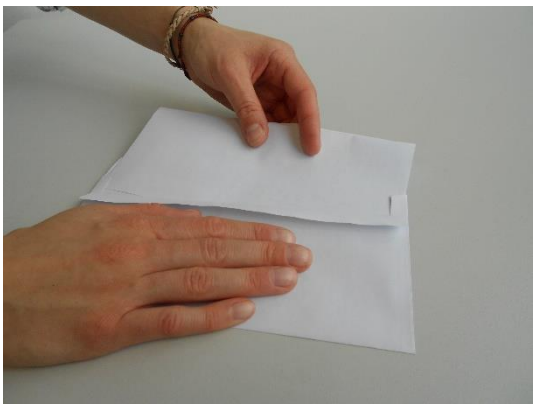
Support # 4: demonstration of action for imitation (see video) or

Support # 5: guidance of the movement (see video).

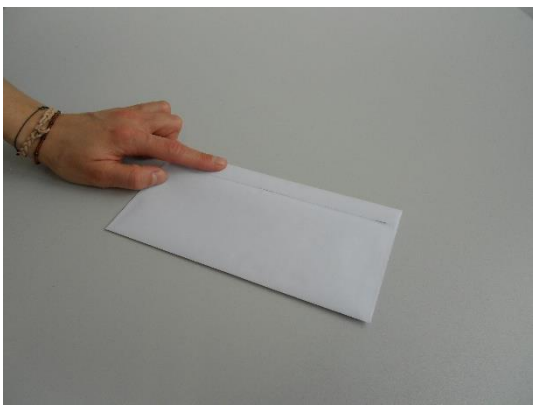
Interim outcome photos:



Fourth, the patient should insert the letter into the envelope. If the patient is not able to do so, help is given via showing the action outcome photo (see first photo), verbal cues (e.g. “Please insert the letter into the envelope.”), interim outcome photos (see photos on the right side), imitation of experimenter action or guided movement.



Fifth, the patient should close the envelope. If the patient is not able to do so, help is given via showing the action outcome photo (see first photo), verbal cues (e.g., “Please seal the envelope.”), interim outcome photos (see photos on the right side), imitation of experimenter action or guided movement.

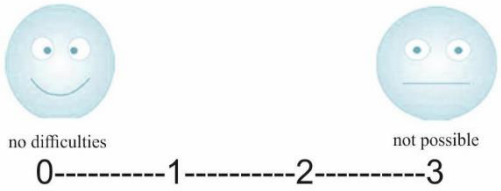


Sixth, the patient is requested to take one stamp from the stamp set. If the patient is not able to do so, help is given via showing the action outcome photo (see first photo), verbal cues (e.g., “Please take one stamp from the stamp set.”), interim outcome photos (see photos on the right side), imitation of experimenter action or guided movement.

Seventh, the patient should affix the stamp. If the patient is not able to do so, help is given via showing the action outcome photo (see first photo), verbal cues (e.g., “Please affix the stamp on the upper right side of the envelope.”), interim outcome photos (see photos on the right side), imitation of experimenter action or guided movement.

Lastly, the patient is asked to tidy up: “Please, put all the objects back into the drawer ”.

After executing the task, the patient is requested to evaluate his own performance of each of the steps (1-6) on the four-point visual-analogue scale. Subsequently, the experimenter provides his judgment. To do so, the experimenter shows the patient photos of each interim goal and the action outcome photo and asks for every step “Did you have any difficulties to select the letter, stamps and envelope/ to fold the letter/ to insert the letter into the envelope/ to close the envelope/ to tear one stamp/ to affix the stamp/ to prepare a letter to send?” Answers range from no (0), few (1) or serious (2) difficulties or not possible to solve (3). Each step is first evaluated by the patient and then by the experimenter.



C: Study data

Thus far (2019), the *Naturalistic Action Therapy* approach has been tested in two subacute stroke patients showing impaired use of familiar tools and diminished insight into their impairment. In addition, five patients participated in a control group without training. Methods and results of this pilot study have been described in Buchmann et al. (submitted).

Further studies on effectivity of this training still need to be conducted.

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E: Example Evaluation Sheets & Material

1. prepare a letter to send

Material

- envelope
- letter
- stamps
- distractors: yellow paper (optic), stickers (semantic)
- photos of the final product, interim target goals and material
- smiley scale

2. fill pill organizing box

Material

- pill organizing box
- 2 sorts of pills (placebo or vitamines)
- distractors: cartonage (optic), Smarties or M&M (semantic)
- photos of the final product, interim target goals and material
- smiley scale

3. make a phone call

Material

- phone
- paper with the written number on it
- distractors: paper with letters (optic), camera (semantic)
- photos of the final product, interim target goals and material
- smiley scale

Prepare a letter to send

Date Session	Material selection					Execution										Tidying up	VATA total		Notes	Points	Percentage Score
	correct (3) verbal cue (2) visual cue (1) experimenter help (0) wrong selection (-1)					independently (5) target photo (4) verbal cue (3) interim target photo (2) imitation (1) guiding hand by experimenter (0)										correct (4) per error/ cue (verbal/ imitation/ guiding hand) (-1)	0 = no / 1 = few / 2 = serious difficulties / 3 = impossible				
	letter	envelope	stamp	wrong	VATA	fold the letter		insert the letter into the envelope		close the envelope		tear one stamp from stamp-set		affix the stamp			total task			38	100%
Baseline 1							VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Baseline 2							VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 1							VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 2							VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 3							VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 4							VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 5							VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 6							VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%

Fill pill organizing box

Date Session	Material selection					Execution																Tidying up	VATA total		Notes	Points	Percentage Score
	correct (3) verbal cue (2) visual cue (1) experimenter help (0) wrong selection (-1)					independently (5) target photo (4) verbal cue (3) interim target photo (2) imitation (1) guiding hand by experimenter (0)																correct (4) per error/ cue (verbal/ imitation/ guiding hand) (-1)	0 = no / 1 = few / 2 = serious difficulties / 3 = impossible				
	pill box	pill package 1	pill package 2	wrong	VATA	open pill box		open pill package 1		get out blister from pill package 1		press pill 1 out of the blister		sort pill 1		open pill package 2		get out blister from pill package 2		press pill 2 out of the blister		sort pill 2		close pill box			total task			63	100%
Baseline 1							VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Baseline 2							VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 1							VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 2							VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 3							VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 4							VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 5							VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 6							VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%

Make a phone call

Date Session	Material selection				Execution										Tidying up	VATA total		Notes	Points	Percentage Score
	correct (3) verbal cue (2) visual cue (1) experimenter help (0) wrong selection (-1)				independently (5) target photo (4) verbal cue (3) interim target photo (2) imitation (1) guiding hand by experimenter (0)										correct (4) per error/ cue (verbal/ imitation/ guiding hand) (-1)	0 = no / 1 = few / 2 = serious difficulties / 3 = impossible				
	phone	paper with number	wrong	VATA	unlock phone	VATA	dial the number	VATA	call (green button)	VATA	hold phone to the ear	VATA	hang up	VATA		total task			35	100%
Baseline 1						VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Baseline 2						VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 1						VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 2						VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 3						VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 4						VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 5						VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%
Training 6						VATA		VATA		VATA		VATA		VATA		Pat	Exp		0	0%