“Use it or lose it” and “Use it and improve it” or better:

Why “swallowing practice” forms the basis of swallowing rehabilitation

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Use it – Swallowing as Training of Swallow Function

Paradigm Change in Clinical Dysphagiology: An Announcement

Robbins JA, Butler SG, Daniels SK, Gross RD, Langmore S, Lazarus CL, Martin-Harris B, McCabe D, Mussion N & Rosenbek JC (2008): Swallowing and Dysphagia Rehabilitation: Translating Principles of Neural Plasticity Into Clinically Oriented Evidencs. *Journal of Speech, Language, and Hearing Research, 51, S276-S300*

Robbins et al. (2008)

Definition of Neural Plasticity

Ability of the brain to change

Robbins et al. (2008)

Definition Central Nervous System Plasticity

Ability of neural systems to alter function in response

to changes in input

both physiological and pathophysiological

Robbins et al. (2008)

Definition Central Nervous System Plasticity

neuronal System

Changes in function are induced by

change and/or adaption in a neural substrate

Robbins et al. (2008)

Plasticity

Neural Substrate

change in a neural substrate leads to

associated bevioral changes

Robbins et al. (2008)

Plasticity

Associated behavioral changes

occur in response to

- Training

Robbins et al. (2008)

Plasticity

Associated behavioral changes

occur in response to

- Environmental cues

Robbins et al. (2008)

Plasticity

Associated behavioral changes

occur in response to

- Experience

Robbins et al. (2008)

Plasticity

Associated behavioral changes

occur in response to

- Aging

Robbins et al. (2008)

Plasticity

Associated behavioral changes

occur in response to

- Injury

Robbins et al. (2008)

Plasticity

Associated behavioral changes

occur in response to

- Disease

Robbins et al. (2008)

Neural Plasticity

Change in synaptic function

within a particular central neural substrate through

- **Synaptogenesis**
- **Long-term potentiation**
- **Long-term suppression**
- **Cell death**

Comprises Neural Plasticity

Robbins et al. (2008)

Neural Plasticity

Neural Plasticity ≠ Behavioral Change

Not all behavioral change involves Neural Plasticity

Robbins et al. (2008)

Neural Plasticity

Neural Plasticity ≠ Behavioral Change

Some behavioral changes result from compensation involving a substitution oder use of different neural substrate(s) for producing a behavior or learning a new function

Robbins et al. (2008)

Neural Plasticity

is

the alteration in function of the original neural substrate

used to produce a behavior

through

changes in synaptic function

Robbins et al. (2008)

Neural Plasticity

There is increasing evidence that

Neural Plasticity plays a substantial role in centrally remodeling human function after cerebral injury

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

If a neural substrate is not biologically active, its function can degrade

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

If a neural substrate is biologiccally inactive, its function can degrade

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

If neural substrate is biologicllay inactive, its function can degrade

- following the loss of peripheral input to the sensory cortex from the hand, cortical somatosensory representation was reduced

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

By increasing environmental input, cortical representation could be altered or enhanced

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

By increasing environmental input, cortical representation could be altered or enhanced

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

By increasing environmental input, cortical representation could be altered or enhanced

- **Studies did show, that cortical loss following peripheral deafness could be prevented by specific treatement**

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Brain Injury

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Brain Injury

- following brain injury, further cortical loss can occur withour training, as the movements formerly represented in the lesioned zone do not reappear in adjacent cortical regions

- failure to drive specific brain function through training can lead to further degradation of a function

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Deglutition (Swallowing)

- Swallowing clinicians recognize this principle

- however: tests of the principle remain to be performed

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Deglutition (Swallowing)

already known effects relevant for Principle 1:

- **Necessity of swallowing „warm-up times“ in patients with neurogenic dysphagia or loss of the volitional swallowing motor patterns**

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Deglutition (Swallowing)

already known effects relevant for Principle 1:

- **these patients not only receive nutrition through alternative routes for extended periods of time,…**

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Deglutition (Swallowing)

already known effects relevant for Principle 1:

- …but they expectorate their own saliva rather than swallow

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Deglutition (Swallowing)

already known effects relevant for Principle 1:

- For years, and in many places to this day, …

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Deglutition (Swallowing)

already known effects relevant for Principle 1:

- **…the assumption in the clinical swallowing community has been that tube feeding is justified because it prevents prandial aspiration and thereby reduces the chance of aspiration pneumonia …**

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Deglutition (Swallowing)

But: Clinicians are uneasy with nil per os (NPO) status at least for 2 reasons:

1. **It is now recognized that aspiration is not alleviated by tube feeding in many circumstances**

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Deglutition (Swallowing)

But: Clinicians are uneasy with nil per os (NPO) status at least for 2 reasons:

2. **The clinical challenge posed by such patients when finally their rehabilitation is attempted is explicable in light of the Use It or Lose It principle**

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Deglutition (Swallowing)

But: Clinicians are uneasy with nil per os (NPO) status at least for 2 reasons:

2. **…: Disuse ot the swallowing mechanism may diminish ist cortical representation and poses a threat to functional recovery in the long run.**

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Deglutition (Swallowing)

Clinical solutions are not transparent.

Robbins et al. (2008)

10 Principle of Neural Plasticity

Principle 1: Use it or Lose it

Deglutition (Swallowing)

Hypothesis: Patients with oropharyngeal dysphagia and life-threatening aspiration should be offered systematic swallowing drills but without using a bolus

Goal: improve their swallowing skill , albeit only on „dry“ or saliva swallows

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Deglutition (Swallowing)

The authors (Swallowing Work Group) do recommend,

To implement a selected subset of methods, which may be used during swallowing and even during the early period of NPO status. The following methods of swallowing intervention have been supported by Phase I and II evidence of effect, and are critical to testing the applicability of the Use It or Lose it principle (see following tables):

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Sensory methods of swallowing intervention. Demonstrated evidence of behavioral or neural pasticity (+) or the lack thereof (-) is noted.

Bolus effects		Behavioral	Neural
Volume	Diet	+	-
Viscosity		+	-
Temperature		+	-
Taste enhancement		+	-

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Sensory methods of swallowing intervention. Demonstrated evidence of behavioral or neural pasticity (+) or the lack thereof (-) is noted.

Stimulation	Behavioral	Neural
Thermal-tactile stimulation (TTS)	+	+
Electrical stimulation („E-stim“)	+	+
Deep pharyngeal neuromuscular stimulation (DPNS)	-	-

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Sensory methods of swallowing intervention. Demonstrated evidence of behavioral or neural pasticity (+) or the lack thereof (-) is noted.

other	Behavioral	Neural
Occluding trach	+	-
Visual feedback (sEMG; FEES)	+	-

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Compensatory methods of swallowing intervention. Demonstrated evidence of behavioral or neural pasticity (+) or the lack thereof (-) is noted.

Compensatory intervention, part 1	Behavioral	Neural
Chin tuck	+	-
Head rotation	+	-
Head tilt	+	-
Head back	-	-

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

Compensatory methods of swallowing intervention. Demonstrated evidence of behavioral or neural pasticity (+) or the lack thereof (-) is noted.

Compensatory intervention, part 2	Behavioral	Neural
Side lying	+	-
breath hold	+	-
Bolus consistency	+	-

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

„Motor with swallow“ methods of intervention. Demonstrated evidence of behavioral or neural pasticity (+) or the lack thereof (-) is noted.

Motor with swallow, part 1	Behavioral	Neural
Mendelsohn[a]	+	-
Super supraglottic	+	-
Supraglottic	+	-
[a]Workshop prioritized as potential for plasticity		

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

„Motor with swallow“ methods of intervention. Demonstrated evidence of behavioral or neural pasticity (+) or the lack thereof (-) is noted.

Motor with swallow, part 2	Behavioral	Neural
Effortfull[a]	+	-
Tongue hold [a]	+	-
Swallow (frequency)	+	-
[a]Workshop prioritized as potential for plasticity		

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

„Motor without swallow“ methods of intervention. Demonstrated evidence of behavioral or neural pasticity (+) or the lack thereof (-) is noted.

Motor without swallow, part 1	Behavioral	Neural
ROM (= range of motion)	+	-
Strengthening - tongue[a]	+	-
Strengthening - respiratory[a]	+	-
[a]Workshop prioritized as potential for plasticity		

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

„Motor without swallow“ methods of intervention. Demonstrated evidence of behavioral or neural pasticity (+) or the lack thereof (-) is noted.

Motor without swallow, part 2	Behavioral	Neural
Tongue control	+	-
Shaker[a]	+	-
Lee Silverman Voice Treatment („LSVT“)[a]	+	-
[a]Workshop prioritied as potential for plasticity		

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

„Motor without swallow“ methods of intervention. Demonstrated evidence of behavioral or neural pasticity (+) or the lack thereof (-) is noted.

Motor without swallow, part 3	Behavioral	Neural
Pharyngeal exercises[a]	-	-
Gargling	-	-
Vocal exercises	-	-
[a]Workshop prioritized as potential for plasticity		

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 1: Use it or Lose it

„Motor without swallow“ methods of intervention. Demonstrated evidence of behavioral or neural pasticity (+) or the lack thereof (-) is noted.

Motor without swallow, part 4	Behavioral	Neural
Velar elevation	-	-
Airway closure / breath hold	-	-
[a]Workshop prioritized as potential for plasticity		

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 2: Use it and Improve it

Principle 2 is an extension of Principle 1

Robbins et al. (2008)

10 Principles of Neural Plasticity

Prinzip 2: Use it and Improve it

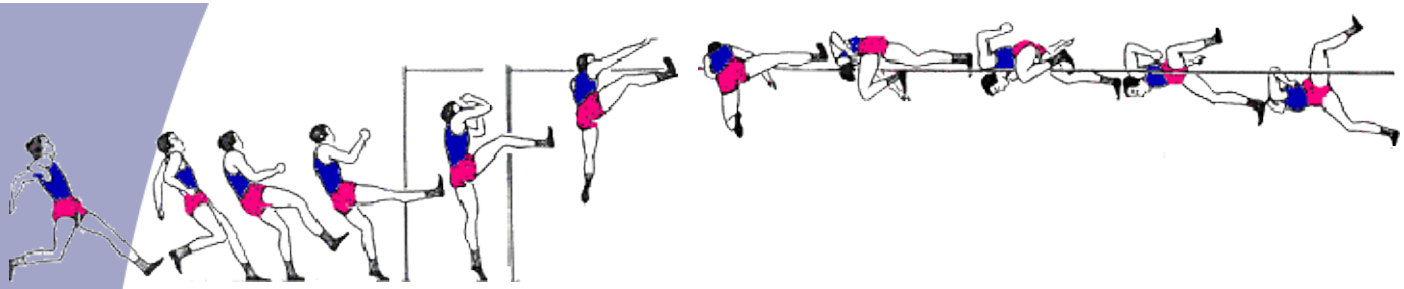
…, indicating that with increased biological activity, future functioning is enhanced, especially if that activity involves skill training or what could be called *target practice*.


Robbins et al. (2008)

10 Principles of Neural Plasticity

Prinzip 2: Use it and Improve it

Principle 2 contains at least one sublety:

Robbins et al. (2008)

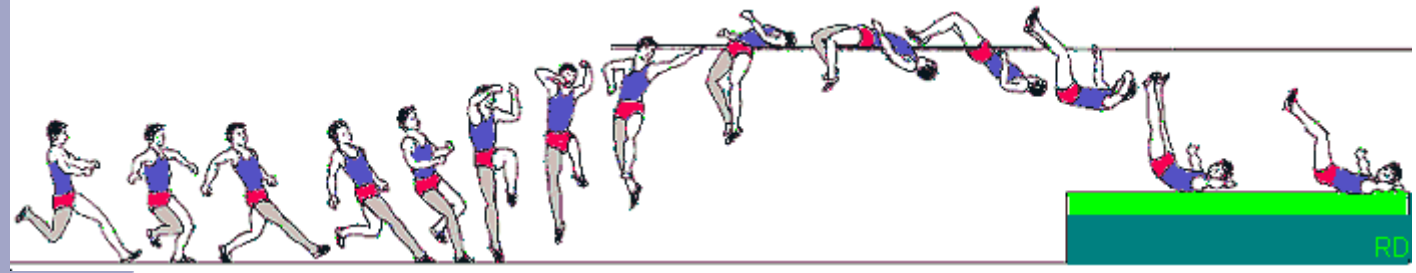
10 Principles of Neural Plasticity

Principle 2: Use it and Improve it

Target Practice

The object is not merely to use a function but rather use a fuction with increasing competence, whether that competence is measured as

- Effiziency



Robbins et al. (2008)

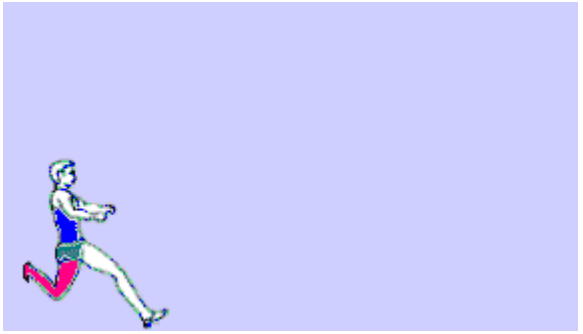
10 Principles of Neural Plasticity

Principle 2: Use it and Improve it

Target Practice

The object is not merely to use a function but rather use a fuction with increasing competence, whether that competence is measured as

- Effiziency



Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 2: Use it and Improve it

Target Practice

The object is not merely to use a function but rather use a fuction with increasing competence, whether that competence is measured as

- Effiziency

or

- Accuracy

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle1: Use it or Lose it
&
Principle 2: Use it and Improve it

The point is that simply swallowing will not necessarily *improve* swallowing by a person with dysphagia

While the negliance of principle 1 may lead to a decline of swallowing function in a specific patient ,

only the combination of intervention methods related to principle 1 and 2 will have the capacity to *improve* disordered swallowing

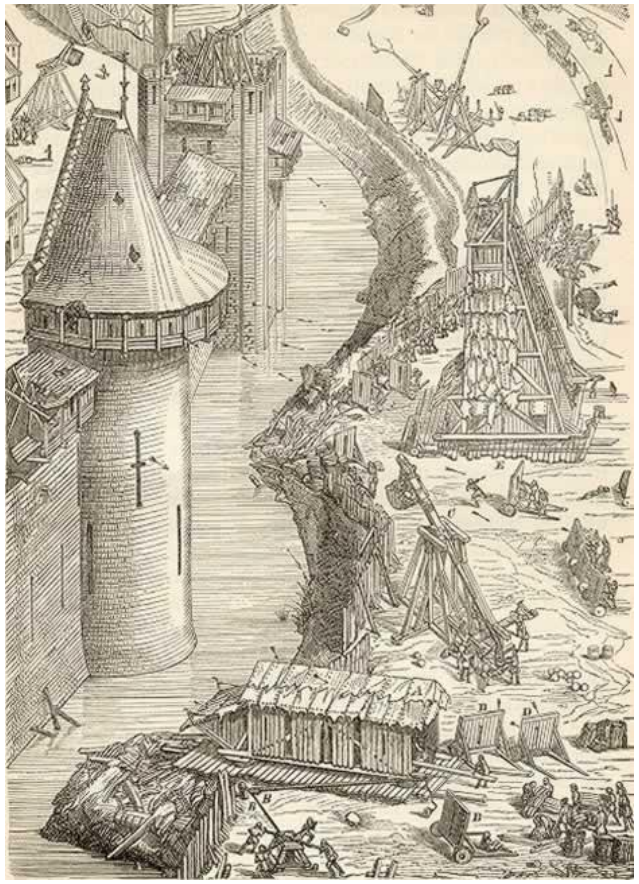
Robbins et al. (2008)

10 Principles of Neural Platicity

Principle 1: Use it or Lose it

If we put more simple in terms of treatment tactics:

Principle 1 = Defence of left swallow function and fortress against further loss of left function



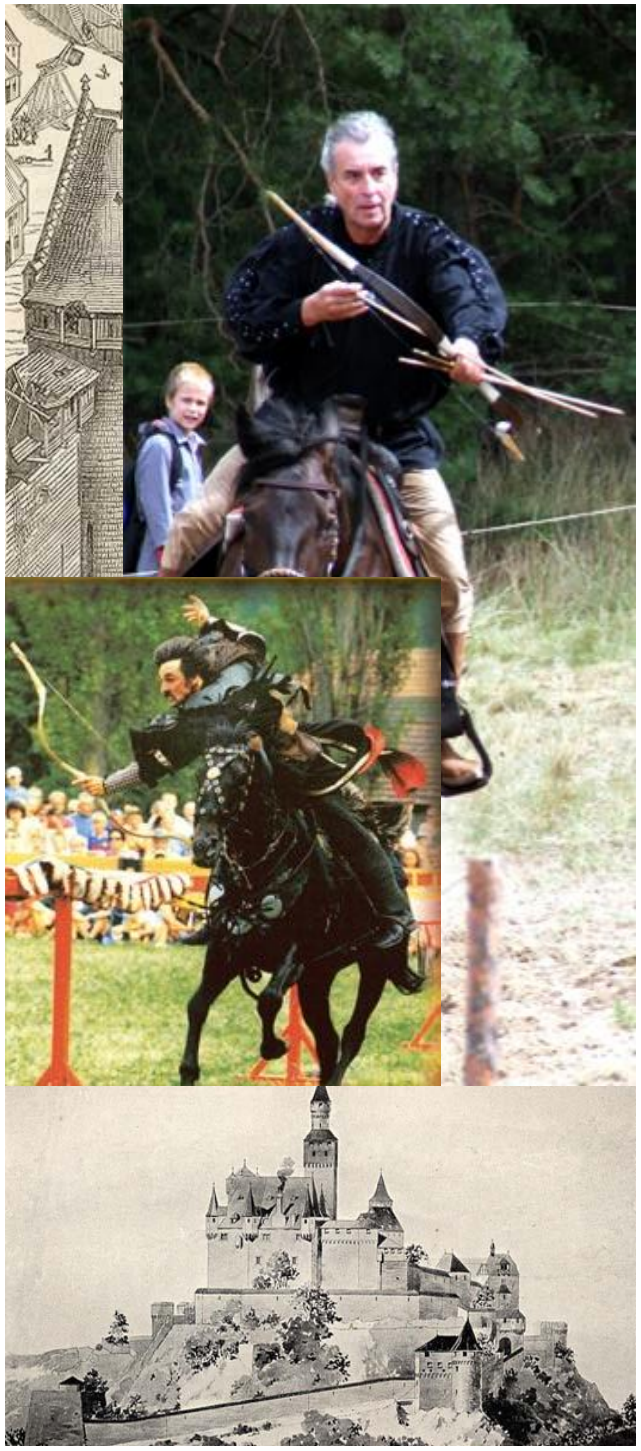
Robbins et al. (2008)

10 Principle of Neural Plasticity

Principle 1: Use it or Lose it
&
Principle 2: Use it and Improve it

If we put it more simple in terms of treatment tactics:

Prinzip 1 & 2 = backed by a strong defence, the attack is being launched by target practice & skill training



Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 2: Use it and Improve it

Target Practice

More food for thought:

Although it has posited that strengthening exercises change vascularity but not cortical or subcortical maps, skill training – such as that involved in the Mendelsohn maneuver – may change both

Robbins et al. (2008)

10 Principles of Neural Plasticity

Prinzip 2: Use it and Improve it

Target Practice

To be normally strong, it takes more than strong muscles

fast, and not weak

strong, but slow

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 2: Use it and Improve it

Target Practice

Firing sufficient motor neurons to the muscle is critical

fast, and not weak

strong, but slow

Where is that?

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 2: Use it and Improve it
Target Practice

If volitional oral events are „recognized“ more readily, they may trigger the pharyngeal swallow response more efficiently

fuzzy

clear

Where is that?

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 2: Use it and Improve it

Target Practice

Such events may be a function of neural plastic adaptation

fuzzy

clear

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 3: Plasticity is experience specific

Changes may occur only in the neural substrates involved in the particular behavior being trained

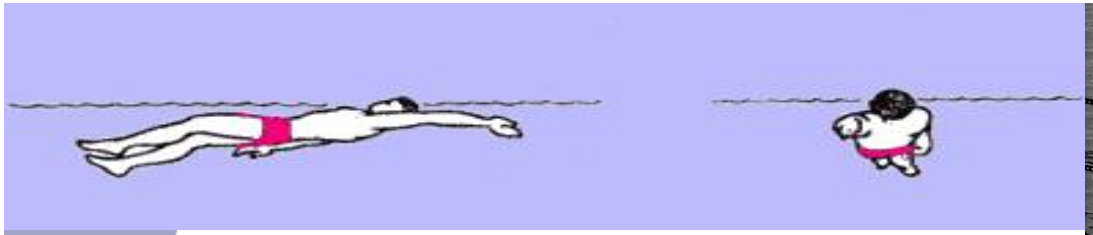
Robbins et al. (2008)

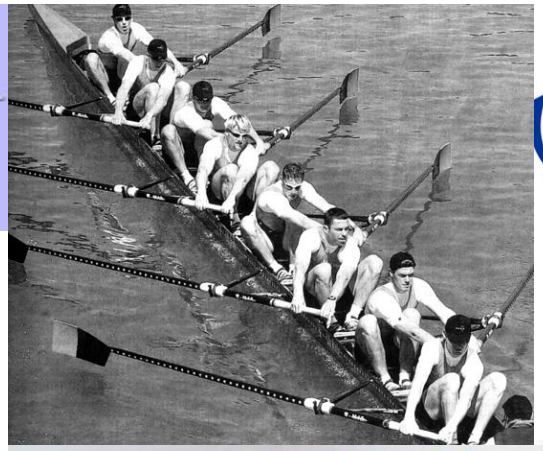
10 Principles of Neural Plasticity

Principle 4: Repetition matters

Neural substrates may be modified by extensive and prolonged practice.

Methods requiring systematic repetition, such as Lee Silverman Voice Treatment (LVST), isometric lingual exercise, and the Shaker Maneuver (head lift exercise) can influence swallowing behaviour



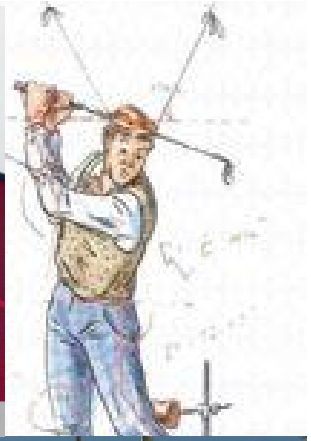


Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 5: Intensity matters

It appears to be a threshold of intensity required to elicit neural change



Robbins et al. (2008)

10 Principles of Neural Plasticity

Prinzip 5: Intensity matters

But: there is the possibility of excitotoxicity with too great a level of stimulation

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 6: Time matters

Protracted (rather than short) periods of training and continuous (rather than intermittend) maximize neural change



Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 7: Salience matters

Purposeful movements

Neural plasticity is best induced when the movement is purposeful and related to the behavior being trained

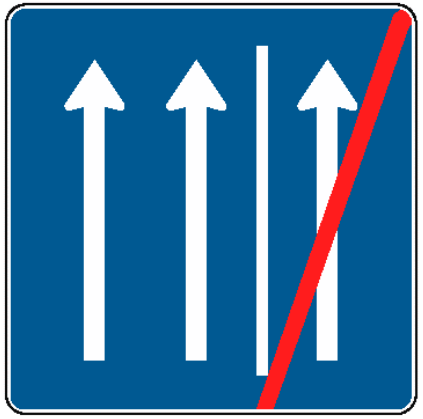
Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 7: Salience matters

Purposeful movements

Marking the importance of a stimulus with input from more basic neural structures is facilitative of functional reorganization



Robbins et al. (2008)

10 Principles of Neural Plasticity

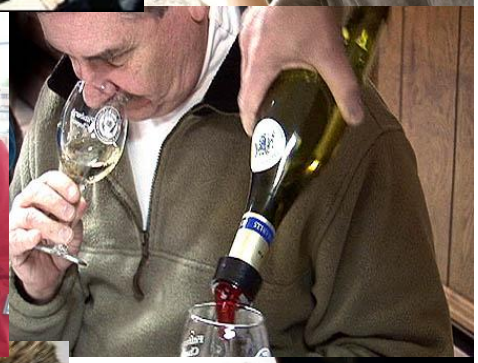
Principle 7: Salience matters

Purposeful movements

Although generalization of animal results to humans must be approached with caution, pairing appropriate environmental stimuli (e.g. taste, smell) with rehabilitation efforts may have a positive influence on recovery








Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 7: Salience matters

Purposeful movements

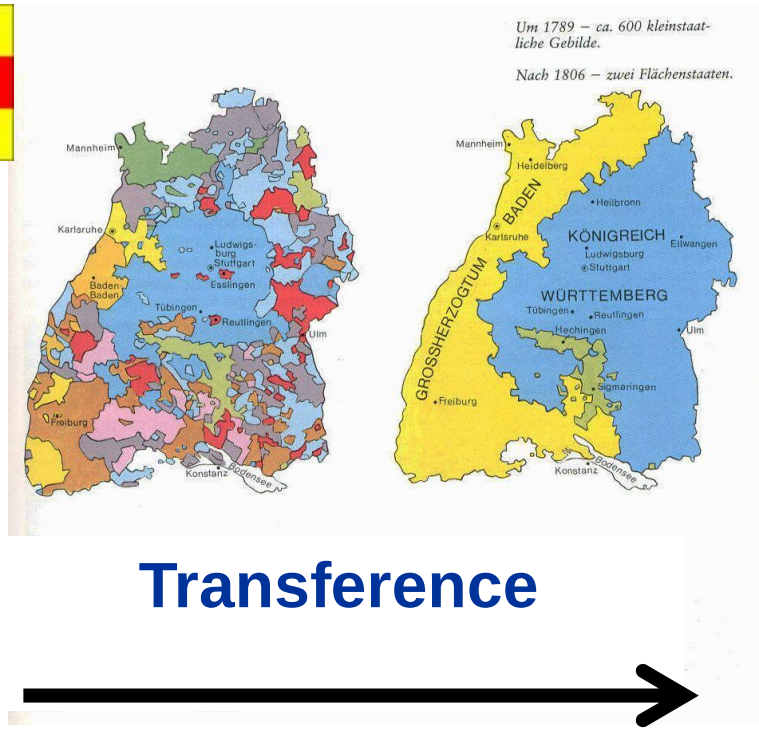
Although generalization of animal results to humans must be approached with caution, pairing appropriate environmental stimuli (e.g. taste, smell) with rehabilitation efforts may have a positive influence on recovery

Robbins et al. (2008)

10 Principles of Neural Plasticity

Principle 8: Age matters

Younger nervous systems are more responsive to training and adaptive neural plasticity than older ones. Nonetheless, neural plasticity does occur over the life span, although outcomes are demonstrated to decrease with age



Robbins et al. (2008)

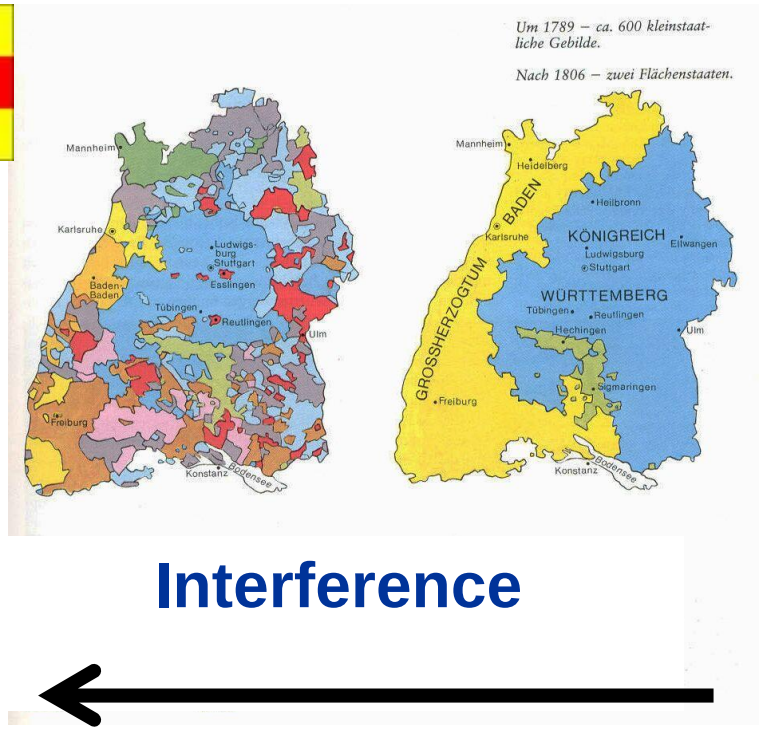
10 Principles of Neural Plasticity

Principle 9: Transference

Transference

Ability of plasticity within one set of neural circuits to promote concurrent or subsequent plasticity:

Examples of the principle include evidence from skill learning and transcranial magnetic stimulation (TMS) – may be able to change cortical swallowing center excitability and map size and locus



Robbins et al. (2008)

10 Principles of Neural Plasticity

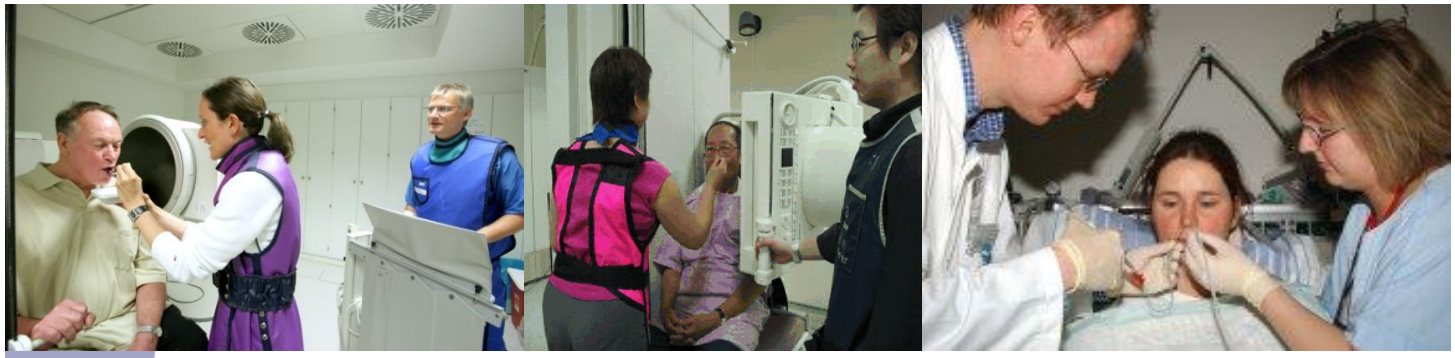
Interference

Prinzip 10: Interference

Ability of plasticity within a given circuitry to impede the induction of new, or expression of existing, plasticity within that same circuitry. The result is that learning or skill acquisition or reacquisition may be hampered

Threat:
NPO may have implications for the neural representation of the swallowing mechanism

Electrical Stimulation has also the potential to cause harm to cortical representation of the swallowing mechanism if not applied properly



How to avoid interference

Avoid non-use situations or NPO-restrictions if possible

Pair effective compensatory methods while measures of airway protection are being taken with rehabilitative approaches to swallowing exercises that require practice over time

Find out what the patient can swallow without risk as early as possible, use imaging when necessary to define the appropriate diet

Don`t wait too long to make decisions.