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Muscle specificity: strength, endurance and functional improvement

*Tongue and lip exercises are frequently recommended for clients with dysarthria and dysphagia but can be of limited functional value. Speech and language therapist **Judi Hibberd** and chartered physiotherapist **Claire Jinks** argue therapists can maximise success by adopting the principle of specificity.*

Speech and language therapists have all used tongue and lip exercises at some time and found them lacking. From a single case study we carried out on our client SL, we believe that lack is specificity.

Specificity is an integral part of how physiotherapists look at exercise. Each muscle has a specific function and, to carry out that function effectively, it needs to have strength and endurance. If a muscle has strength, it has the power to perform a function. If it has endurance, it can continue to perform that function without fatigue.

"*Strength* may be defined as the maximal effective force that can be actively exerted by a muscle in a specific movement" (Galley & Forster, 1996). In relation to muscle improvement, it is important to note "strength will not be increased by the mere repetition of exercise of the same intensity over a period of time" (Hellebrandt & Houtz, 1958) as repetition can only increase endurance. "*Endurance* may be defined as the ability to continue a particular dynamic task accurately for a prolonged period of time" (Galley & Forster, 1996).

As a principle, specificity looks at the everyday functional needs of a patient. It is decided which muscles are needed for each function and exercises are then formulated to promote strength and endurance of the muscles in question. Therapy can only be effective if both these areas are treated.

No improvement

Given his history, SL seemed an ideal candidate for a case trial using the principle of muscle specificity for tongue and lip exercises. He was admitted to hospital in March 1997 following a mid-brain infarct. This resulted in a left hemiplegia, dysarthria and dysphagia. He was nil by mouth initially with nasogastric feeding, then had a PEG (percutaneous endoscopic gastrostomy) tube inserted in May 1997 because he was unable to swallow. Throughout his five month stay in hospital SL had regular therapy, including tongue and lip exercises (for repetition five times each, three times a day), production of single syllable words in lists and thermal stimulation. Unfortunately, at the time of his discharge to a nursing home, there had been no improvement in either his dysarthria or swallow.

Although it is well known that muscle strength reduces with age, it is also claimed that, regardless of age, muscle has the capacity to improve (Galley & Forster, 1996). As SL was 68, we thought it would be interesting to bear this claim in mind during the trial.

Modification of exercises

We began by identifying the specific muscles used in present tongue and lip exercises (Davies & Coupland, 1997; Perlman & Schulze-Delrieu, 1997)

Figure 1 - Muscles used

EXERCISE / ACTIVITY	MUSCLE TARGET
1. Tongue protrusion	<u>Genioglossus</u> and <u>Hypoglossus</u>
2. Lateral tongue movement	Intrinsic muscles of the tongue assisted by the <u>Styloglossus</u>
3. Tongue elevation front	Intrinsic muscles of the tongue
4. Tongue elevation back	<u>Styloglossus</u>
5. Lip closure	<u>Orbicularis Oris</u>
6. Lip spread	<u>Zygomaticus Major</u>

We then modified the exercises to ensure both endurance and strength aspects were targeted.

Figure 2 - Exercises

EXERCISE	EXERCISE REGIME	
	ENDURANCE utilising repetition	STRENGTH utilising resistance
Tongue protrusion	Move tongue in and out	Push tongue out against bowl of spoon held by someone else
Lateral tongue movement	Move tongue into corners of mouth alternately	Spatula held by someone else along lateral edge of tongue. Move tongue into corner of mouth against spatula
Tongue tip elevation	Lift tongue tip out of mouth toward the top lip	Using the bowl of a spoon held by someone else, lift tongue tip up into spoon bowl
Back of tongue elevation	THERASpoon 4 (Kapitex) held over back of tongue, requiring patient to lift tongue to touch it	THERASpoon 4 placed on back of tongue and light resistance used as patient elevates back of tongue
Lip rounding	Patient asked to round lips as in <i>ooo</i> , then relax lips	Facial flex placed in mouth. Patient required to compress then release it
Lip press	Patient presses lips together and lets go	Finger stall applicator put between top and bottom lips and pressed together

For improvement of endurance in a muscle, an exercise must be repeated a number of times. Endurance is shown by the number of times a movement can be repeated without resistance. To improve strength, some resistance is necessary. For the lateral tongue exercise, where a patient is required to move their tongue from side to side, this can be applied by holding a spatula along the side of the tongue, thus requiring them to push against the spatula to move the tongue laterally. In the lip closure exercise, resistance can be applied by placing a finger stall applicator between open lips with the patient pressing the applicator together with the lips. The amount of resistance necessary, for any of the exercises, is unable to be quantified at this point.

Baseline assessment

The aim of the trial was to improve both swallowing and speech. At its commencement a baseline of ability was documented.

Swallowing assessment showed SL was aspirating. He had a poor oral phase, so liquids were passing over the tongue base and into an open airway before he could initiate a swallow sequence. Compensation of a breath hold allowed him to have a few sips safely, but not enough for adequate hydration. Food was not possible because tongue control was so poor.

To set a baseline of ability for the tongue and lip exercises the *overload principle* was applied (Trew, 1997). This takes a person beyond their present physical ability. Thus SL was asked to carry out each exercise until the muscle was tired or the therapist observed that the movement became uncoordinated. The number of repetitions achieved was the baseline for that exercise. There was often a marked difference in the baselines for strength and endurance. For example, in the tongue protrusion exercise SL had an endurance baseline of ten repetitions but a strength resistance repetition limit of only four. This may account for the discrepancy that occurs when a patient's exercises are good but speech is still unintelligible, as speech requires both strength and endurance. In other exercises (tongue lateral and lip round), SL achieved more repetitions with resistance, as range of movement was more limited with resistance and was therefore less painful.

Goal setting

Due to the severity of SL's condition, the baseline level of ability for each exercise was very low. We put a time limit on the case study, deciding to see what SL could achieve in a six week period rather than setting him a final numerical target.

The patient, speech and language therapist and physiotherapist set the goal for each exercise together weekly. Initially a baseline was established and a goal agreed for the next week. We considered an increase in each exercise by one repetition per week an achievable target, so minimising the risk of failure. We stipulated the goal must be reached at every practice.

Each exercise had a pictorial representation, details of the baseline and the expected outcome for each week (examples in figures 3, 4 and 5). Achievements were charted weekly.

Figure 3 - Back of tongue elevation using THERASpoon 4



 ENDURANCE Lift back of tongue to touch THERASpoon 4	 STRENGTH Push THERASpoon 4 down against back of tongue whilst lifting tongue up
STAGE 1 Baseline: Work needed:	STAGE 1 Baseline: Work needed:
STAGE 2 Today's level: Work needed:	STAGE 2 Today's level: Work needed:
STAGE 3 Today's level: Work needed:	STAGE 3 Today's level: Work needed:
STAGE 4 Today's level: Work needed:	STAGE 4 Today's level: Work needed:
STAGE 5 Today's level: Work needed:	STAGE 5 Today's level: Work needed:
STAGE 6 Today's level: Work needed:	STAGE 6 Today's level: Work needed:

Figure 4 - Lip rounding


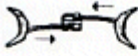


	<p>ENDURANCE Round your lips into the shape for ooo and then let go</p>		<p>STRENGTH Push the flex together with your lips, then relax the flex</p>
<p>STAGE 1 Baseline: Work needed:</p>		<p>STAGE 1 Baseline: Work needed:</p>	
<p>STAGE 2 Today's level: Work needed:</p>		<p>STAGE 2 Today's level: Work needed:</p>	
<p>STAGE 3 Today's level: Work needed:</p>		<p>STAGE 3 Today's level: Work needed:</p>	
<p>STAGE 4 Today's level: Work needed:</p>		<p>STAGE 4 Today's level: Work needed:</p>	
<p>STAGE 5 Today's level: Work needed:</p>		<p>STAGE 5 Today's level: Work needed:</p>	
<p>STAGE 6 Today's level: Work needed:</p>		<p>STAGE 6 Today's level: Work needed:</p>	

Figure 5 - Lip press

	<p>ENDURANCE Press your lips together and let go</p>		<p>STRENGTH Put the applicator between your lips and press it together and let go</p>
<p>STAGE 1 Baseline: Work needed:</p>		<p>STAGE 1 Baseline: Work needed:</p>	
<p>STAGE 2 Today's level: Work needed:</p>		<p>STAGE 2 Today's level: Work needed:</p>	
<p>STAGE 3 Today's level: Work needed:</p>		<p>STAGE 3 Today's level: Work needed:</p>	
<p>STAGE 4 Today's level: Work needed:</p>		<p>STAGE 4 Today's level: Work needed:</p>	
<p>STAGE 5 Today's level: Work needed:</p>		<p>STAGE 5 Today's level: Work needed:</p>	
<p>STAGE 6 Today's level: Work needed:</p>		<p>STAGE 6 Today's level: Work needed:</p>	

It was up to the patient, his wife and carers how many times he practised, for example, ten times a day, once a day or once every two days. In this case, he never missed a daily practice except when all work was abandoned during a two week period of illness. A complete set of exercises was built up gradually. Unfortunately, lateral tongue movement had to be discontinued due to a painful right temporo-mandibular joint.

Functional improvement

SL had shown no functional improvement at all over the five months of inpatient therapy with conventional use of tongue and lip exercises. In only a few weeks, however, these specificity exercises saw an improvement in every area (figures 6 and 7) and the functional evidence shows SL's speech is now

intelligible to the degree that trained listeners - staff and family - can understand his needs. His swallow is now safe and he can achieve hydration orally without his breath held. He can also now take liquidised food.

Figure 6 - Endurance results

ENDURANCE EXERCISE RESULTS (No. repetitions)		
EXERCISE	BASELINE WEEK 1	ACHIEVEMENT WEEK 6
TONGUE PROTRUSION	10	14
TONGUE LATERAL	3	NOT COMPLETED AS TOO PAINFUL
TONGUE ELEVATION FRONT	3	9
TONGUE ELEVATION BACK	0	4
LIP ROUND	6	10
LIP SPREAD	6	8
LIP SPREAD/ROUND	3	8
LIP PRESS	8	10

Figure 7 - Strength results

STRENGTH EXERCISE RESULTS (No. repetitions with resistance)		
EXERCISE	BASELINE WEEK 1	ACHIEVEMENT WEEK 6
TONGUE PROTRUSION	4	5
TONGUE LATERAL	4	6
TONGUE ELEVATION FRONT	3	5
TONGUE ELEVATION BACK	0	4
LIP ROUND	8	10
LIP SPREAD	NOT INCLUDED	NOT INCLUDED
LIP SPREAD/ROUND	NOT INCLUDED	NOT INCLUDED
LIP PRESS	4	10

Improving breathing

This is only a very small trial in what could become a large area of research and we hope the positive results may encourage others into research. We are now also looking into improving SL's breathing using the principle of specificity. Studies show subglottic pressure is important in a safe swallow (Eibling and Gross, 1996). Deep breathing exercises can teach a patient how to increase their inspiration, therefore increasing the amount of air in their lungs. During swallowing, respiration is suspended, therefore the increased air in the lungs improves the thoracic pressure which in turn will have an effect on the subglottic pressure. The physiotherapist has given exercises utilising resistance of the intercostal muscles to promote rib cage expansion. We are also using 'huffing' exercises for control of expiration, the resistance being the adduction of the vocal cords to produce the 'huff'.

We have both found the chance to work with another profession very instructive and feel closer contacts between speech and language therapists and physiotherapists should be encouraged.

Judi Hibberd is a speech and language therapist and Claire Jinks a chartered physiotherapist. They are both self-employed therapists. The case study was undertaken at a nursing home, part of Extra Care Charitable Trust, based in the Midlands.

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Resources

- THERASpoons are available from Kapitex, tel. 01937 580211.
- Contact authors re- the facial flex at 18 Hodgetts Lane, Burton Green, Kenilworth, Warwickshire CV18 1PJ.

Questions

- **What is the principle of specificity?**
- **How can a baseline be measured?**
- **Which commercially available products are useful for providing resistance?**

Answers

- **Specificity holds that muscle function can only be improved by building both strength and endurance.**
- **The number of repetitions made until a muscle tires, with and without resistance, form baselines.**
- **A spatula, facial flex, finger stall applicator and THERASpoons can provide resistance in various tongue and lip exercises**