Grasping Speech Sounds

Spelling is a complex, linguistically based literacy skill. An individual's ability to spell independently relies upon his or her underlying knowledge of phonology, orthography, morphology and mental graphemic representations.

Apel, Masterton and Hart (2004, p. 292)

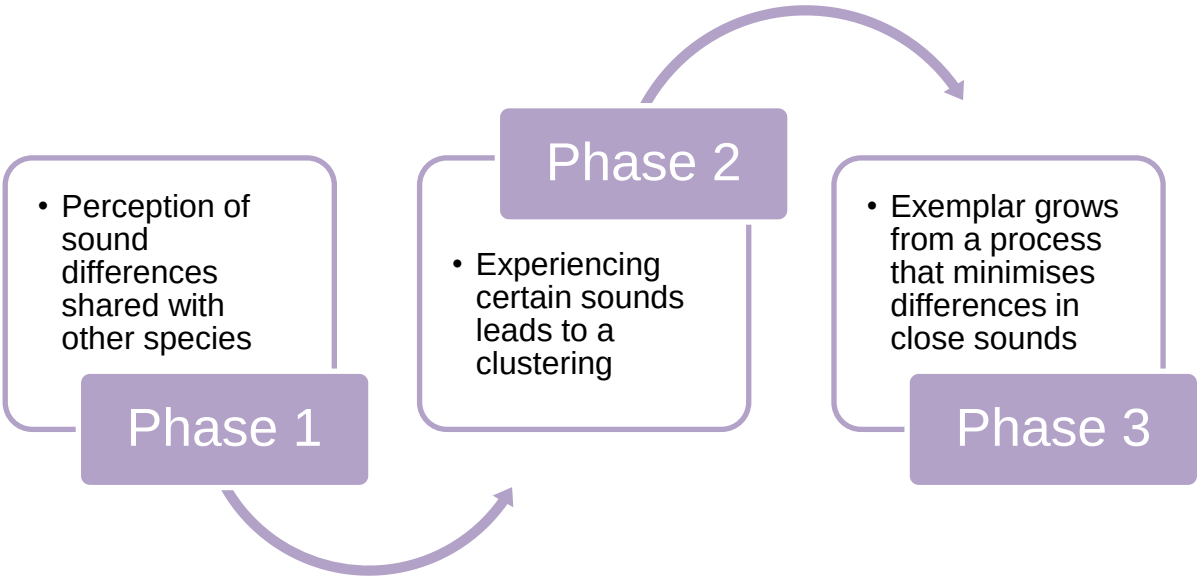
It is worth lingering upon this quote from Apel, Masterton and Hart, to unpack its intricacies, however in this lecture we will be most concerned with aspects of phonology and the linguistic underpinnings of spelling. Understanding these underpinnings can enhance our ability as teachers to strategically support learners who are struggling with spelling (Bourassa and Treiman, 2000). Though so often called 'spelling errors', perhaps are more usefully considered as representations, that reflect the learner's underlying assumptions about speech sounds and how to transcribe them. Louisa Moats ably sums up the key knowledge we, as specialist literacy teachers and assessors need to know if we are to tackle literacy difficulties effectively, she writes, "the content knowledge required for effective instruction and intervention includes knowledge of English orthography and the various ways that it represents spoken language. English is a ...''deep'' alphabetic orthography. Its spellings map onto speech sounds quite predictably, although correspondences are complex and variable... "stable", "establish", and "stability" use the same spelling for the Latin root, "stab", even though the morpheme is pronounced differently in each word. Explicit and complete explanations of such words require reference to sound, spelling, word origin and meaning. Word-level knowledge such as this, moreover, is only part of what teachers need to know..." (2009, p. 380 – 381). This lecture serves as an introduction to speech sounds and how understanding something of speech dynamics can enlighten our understanding of learners' unconventional spelling representations.

Perceptual Issues

Before looking at speech dynamics, we will briefly consider some of the perceptual issues that learners who are struggling spelling might display. For example, the discrimination of vowel sounds is very often not typical in those affected by dyslexia (Bernstein, 2009). Vowels are the central target for many remediation programmes in English (for example, Alpha to Omega by Hornsby and Shear, 1993) and other languages (for example, German: Ise & Schulte-Körne, 2010). Indeed, the ACE Spelling Dictionary (Moseley and Nicol, 1989) puts a central focus upon the perception of the vowel sounds within words.

Kuhl's (1998) Native Language Magnet theory (NLM) is a useful model to consider when we are conceptualising the particular perceptual difficulties that learners with dyslexia might have, or indeed that learners who are learning English as an additional language might have. The NLM theory assumes self-organisation in typical development – whereby experience of a language trains the ear to hear the sounds of the native language and screen out irrelevant differences. Ironically this means that becoming less aware of differences in spoken sounds is the norm and that retaining the ability to hear closely related sounds as different can hamper development.

NLM is a three-phase model:



Phase 1: Infants have acoustic boundaries that are not specialised for linguistic purposes. Other animals have similar basic boundaries. These boundaries create spaces within which tokens (by that I mean memory-traces of speech sounds) are stored.

Phase 2: Around 6 months-of-age the infant's linguistic environment causes predispositions to form. The child's experience of hearing certain sounds has led to clusters of tokens forming.

Phase 3: Each cluster merges together to form a 'magnet' a sort of exemplar of that vowel or consonant phoneme type – this causes "certain perceptual distinctions to be minimised [those nearest to the central cluster], while others are maximised [those near

the boundaries between clusters]" (Kuhl, 1998, p 183). This really means that neural networks that process other speech sounds not approximating to any of the exemplars disappear. By this process the general acoustic boundaries that the baby was born with are eradicated and native language-boundaries are established: *the memory clusters are organised into a system that now defines what is heard*. An example that you might be familiar with is that native Chinese speakers typically have a reduced perception of some phonetic contrasts not extant in their mother-tongue, for example like that between /l/ and /r/.

The complexity of the speech process

It has been shown that very young infants of 6 months of age can treat the same vowel sound uttered by a man, woman and child as essentially the same sound (Kuhl, 1983) – this is amazing when you think about how different these would actually be. It is worth asking a few people (differing in age, gender and so on) to say a particular vowel sound to you, in order to demonstrate the extraordinary feat that very young children typically achieve. It emphasises the complexity of the task of speech perception and communicating via speech. As Li Deng puts it: "… the speech chain is a highly dynamic process, relying upon the coordination of linguistic, articulatory, acoustic and perceptual mechanisms that are individually dynamic as well" (2006, p.4).

Van Leeuwen and colleagues (2008) examined how accurately babies were able to categorise phonemes. Their findings demonstrated impaired categorisation of phonemes in infants at familial risk of dyslexia as young as two-months old. Learners with dyslexia have also been shown to be sensitive to boundaries that are non-phonemic in English but native in Thai, which suggests that their hearing of sounds has not been pruned to suit the native language as in the usual course of development (Bogliotti, Serniclaes, Messaoud-Galusi & Sprenger-Charolles, 2008; Serniclaes, Van Heghe, Mousty, Carre & Sprenger-Charolles, 2004). Jointly these findings support the suggestion that young learners with dyslexia are perceiving and processing allophones i.e. they are hearing sounds as different when typically developing children would hear them as the same phoneme (Serniclaes, Sprenger-Charolles & Carré, 2001). So, it seems likely that, for certain sounds at least, clustering has not occurred so no archetypal (exemplar) sound develops. In such cases, this means that the learner would be processing and discriminating far more sounds than you, as a teacher or assessor, are aware of. This means, for example, the vowel sound in 'tan' and 'sap' might be considered the same by the tutor, so it seems obvious to the tutor that both map on to the same grapheme 'a'. But actually, the sounds are subtly different: /n/ nasalises the

vowel in ‘tan’ and /p/ cuts the vowel short in ‘sap’. So, we can consider in this respect at least, that learners with dyslexia do not have a deficit, but rather a superfluity: they are battling with even more complexity and variety than we can imagine. This is why links need to be made explicitly and in a structured way that supports retention in long-term memory. To go back to what I said earlier, becoming less aware of differences in spoken sounds is the norm; retaining the ability to hear closely related sounds as different can hamper development. This underlines the importance of doing a thorough test to check that the learner can discriminate sounds typically. If this is not the case then practice is needed, or perhaps you need to consider asking for specialist advice.

One final aspect that needs to be highlighted is that children can be distorting sounds during their sincere efforts to capture them. As Renate Valtin notes: “Observations show that children, when analyzing the sound structure, orient themselves primarily to articulatory cues, saying the words slowly out loud and trying ‘to catch’ all the sounds of their pronunciations” (1997, p. 184). But the slowing down of articulation changes the quality of the vowels – we need to watch for this otherwise further layers of confusion can be added. Try saying the word ‘bin’ slowly, notice how the vowel sound becomes less like /ɪ/ and more like /e/. It’s also worth pausing to consider how slowing down the articulation of words might actually not be a good thing, because it distorts the phonemes in the sense that they will be less like the actual phonemes the learner will hear when the word or words are spoken at normal speed. An example, that is interesting to ponder, is one given by Grossberg & Myers (1999, p. iii) they say: “During fluent speech perception, variations in the durations of speech sounds and silent pauses can produce different perceived groupings. For example, increasing the silence interval between the words "gray chip" may result in the percept "great chip", whereas increasing the duration of fricative noise in "chip" may alter the percept to "great ship".

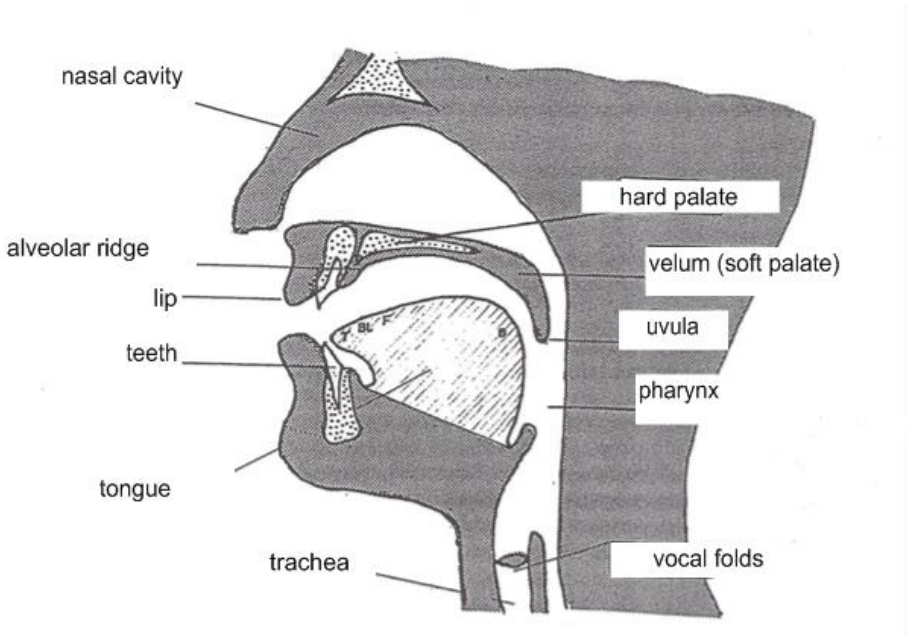
Speech Dynamics

We tend not to notice the variability of phonemes when we utter them in streams of speech *if we know who to spell those words*. This demonstrates how our knowledge of standard English orthography (i.e. the symbols used to capture speech sounds in English) blocks many of us from hearing the dynamic changes in rapid spoken speech and even within words. Yet it is exactly this knowledge of speech dynamics that we need to strengthen if we are to enhance our ability to remediate spelling difficulties. When we are aware of the ways in which English consonant phonemes are classified, we can begin to see patterns in representations that we would otherwise miss. This not only potentially saves a lot of time,

but it also makes us knowledgeable about the source of the representation – something we can transmit to the learner. All too often learners assume that the spelling difficulties are located within themselves; they can view themselves as 'bad spellers'. Focusing upon how speech dynamics affect pronunciation within words and across utterances, re-frames the difficulty with spelling by referencing the inherent problems with using the transcription of speech sounds as a spelling strategy. We can say things like, "I know that's how the word sounds, but we can't always rely upon the sounds within words when we are spelling, they are just not reliable enough"....

In order for us to discuss speech sounds more accurately, we need to run through some definitions. There are four main factors that determine the nature of the speech sounds that we make:

1. The vocal folds (popularly known as vocal cords) – whether or not they vibrate as the sound is produced
2. The velum's (our soft palate) position
3. The tongue movements made
4. The lips' shape/position



To go back to the vocal folds, if the folds vibrate when the sound is made then that sound is said to be 'voiced', when they don't vibrate the sound is classified as 'voiceless'. This is a

major distinction in speech sounds... In some instances, the vocal folds are held open long enough and wide enough to trap an additional pocket of air – this is released as a 'puff' after the phoneme as in /p/ - try holding your hand to your mouth and saying /p/: you will feel it. This is known as 'aspiration'. If the velum is closed it channels the air in to the oral cavity so the sound is classified as 'oral'. If open air flows in to the nose, the sound is classified as 'nasal' (Zsiga, 2006).

Getting to grips with the technical terms connected with speech production and seeing how different types of speech sound are related diagrammatically helps our understanding as teachers and sharpens our practice. The place of articulation is a key feature in the production of speech sounds. Being able to categorise speech sounds by place of articulation is an essential for two reasons:

- It enables us to clarify the process of articulation for learners and allows us to make links to sounds that have similar characteristics.
- Knowing the place of articulation can enhance our ability to spot patterns in sets of spelling errors that might at first seem bizarre or random.

The chief sites of articulation, working from front to back, are as follows:

1. Bilabial: describes the category of sound produced when both lips come together, as in /p/ or /b/.
2. Labio-dental: describes the category of sound produced when the lower lip touches the tips of the upper front teeth.
3. Dental: describes sounds where the tongue tip touches the back of the upper teeth.
4. Alveolar sounds are produced when the tongue tip is touching the alveolar ridge (the bony outcrop just above the upper teeth).
5. Palato-alveolar sounds are produced when the tongue moves further back pointing towards the hard palate, /tʃ/ /dʒ/ /ʃ/ /ʒ/ are members of this family of sounds.
6. The notoriously tricky sound /j/ is made by the tongue pushing up towards the hard palate – it is classified as a palatal sound.
7. Velar sounds are the result of a constriction right at the back of the mouth (Sziga, 2006)

8. The final main category is 'glottal' – the glottis is part of the larynx (the voice box); it consists of the vocal folds and the slit-like opening between them. Sounds of this

type are made “furthest back just using the glottis” (Culpeper et al., 2009, p. 19) - /h/ is an example of this.

On this diagram the place of articulation works from front of the mouth (bilabial) to the glottis at the very back.

	Plosive (Stop)			Affricate			Fricative			Nasal			Approximant*		
Bilabial	p	b									m			w	
Labiodental							f	v							
Dental							θ	ð							
Alveolar	t	d					s	z			n			l	
Post Alveolar														r	
Palato-Alveolar				tʃ	dʒ		ʃ	ʒ							
Palatal														j	
Velar	k	g									ŋ			w	
Glottal							h								

The next way of categorise speech sounds is to look at the manner of articulation; at the process of how they are produced:

Plosives (also called stops) are the result of a build-up of air being suddenly released. As you can see from the diagram, there are six of these sounds – three ‘voiced” – in the greyed column i.e. /b/, /d/ and /g/ and three ‘unvoiced’ - /p/, /t/ and /k/.

Fricatives are like incomplete plosives, in that a small opening is left which allows air to flow through with some force (i.e. friction). Again these come in voiced and unvoiced pairs: /v/ and /f/, / ð/ and / θ/, /z/ and /s/ and finally /ʒ/ and /ʃ/. There is also the glottal fricative /h/ but we won’t dwell too much on that...

The affricates are a mixture of a plosive then fricative within a single phoneme – there are only two /tʃ/ (unvoiced) and /dʒ/ which I am sure you can hear is (voiced). Zsiga (2006)

suggests saying ‘achoo’ very slowly whilst noting the movement of your tongue, to get the dynamics of this sort of sound.

The nasals are self-explanatory – and are usually voiced. These can cause particular spelling problems and we will return to this later.

The approximants include the glides /w/ and /j/ and the liquids /l/ and /ɹ/ - they are usually voiced – but are very changeable and therefore difficult to pin down spelling-wise.

Plosives

This sort of devoicing has huge ramifications for learners who are primarily using their own speech as their springboard to a spelling**. /b/ /d/ /g/ /v/ /ð/ /z/ /dʒ/ /ʒ/** are usually voiced in isolation but during rapid speech devoicing occurs... say ‘the snag seems’ slowly articulating each word... now say if faster... do you hear how the /g/ shifts to a /k/ sound?

Smith and Bloor give the example of ‘the dog sniffs’ compared to ‘the dog growls’ – if spelling by speech sounds a learner could spell ‘dog’ as ‘dock’ in the first phrase and ‘dog’ in the second: this could give the impression of carelessness (p. 15), when it is actually a faithful representation of what the learner hears. Look at the example on screen ...

‘A dog sniffs and dog growls’... Our knowledge of spelling can block these subtle nuances – we think we hear the sounds that should be there according to the spelling because we screen out the actual sounds as they are uttered, as we have automated the speech to spelling conversion processes and are no longer relying upon the dynamics of the speech sounds themselves. Many of the learners we are working with will not have the benefit of a suitably adjusted filter, nor the ability to accurately automate spelling processes.

If we look at the sounds in the nasal and the approximant column we come upon the troublesome group **/ m / /n / /ŋ / / l / /r/ / j /** and **/w/**, that are usually voiced, but that become devoiced in blends when they follow a voiceless phoneme. This makes the spelling of blends containing these letters complex i.e. you can't rely on sound to cue the letter name as in some words some of the phonemes virtually disappear. Try reading the blends (like 'cr' for example) then say the whole word that follows it pausing after the blend, then say the whole work quickly. For example, 'cr....cr...est...crest'. Some of the transformations are surprising and I am sure that what you hear will resemble spellings that you have seen many times before like 'sgach' for 'scratch' or 'pam for 'pram', 'sap' for 'slap' and so on... Treiman and Bourassa (2000) noted that some children in their study represented /t/ before /r/ as / tʃ /, for example, spelling 'trap' as 'chrap' or 'track' as 'chrac.' Such representations may seem bizarre but do make phonetic sense: /t/ approximates to / tʃ / when it occurs before /r/. And a /d/ before /r/ is articulated with a degree of turbulence that is similar to /dʒ/.

cr	crest
fl	flag
fr	frog
pl	pleat
pr	pram
scr	scratch
shr	shrill
sl	slap
sn	snout
sm	smell
spl	slash
spr	spring
squ	squash
str	strap
sw	swirl
thr	throb
tr	trap
tw	twenty

Assimilation

Now let's turn to assimilation. "Assimilation is the phonetic accommodation of sounds to their neighbours" (Culpeper et al., 2009), in other words sounds can be affected by those surrounding them. This arises to make articulation more efficient really, though some people think it carelessness. Some phonemes are less stable than others. The nasal sounds /n/ and /m/ are particularly prone to be influenced by the following consonant. It is crucial to have an understanding of this phenomenon if we are to see children's spelling representations for what they often are: veridical transcriptions of dynamic speech. Many of us think that we don't assimilate words and sounds within words: thinking only those who speak in a sloppy, casual way do it. This simply isn't the case.

Smith and Bloor (1985) tell an enlightening story of John – a very bright ten year old. He had made rapid progress with structured tuition, both reading and spelling had improved considerably: his b/d confusion had largely evaporated. However, when working on words ending in *-ssion*, John spelt *admission* as *abmission.* The tutor was at first dismayed, thinking he'd slipped back in to his old habits, but then it occurred to her to ask John to say the word. He clearly said: "Abmission...I thought it came from abmit – you know, abmit one to the football match" (p. vii). Think how much time could have been spent on strategies that were not appropriate for John ('bed' as a visual clue, or 'baby b is inside big B' etc.) that could have frustrated and/or bored him. Fortunately for John, his tutor could see that the /d/ was being assimilated forward to a /b/ because of the /m/ that followed it. So she "made a mental note to do some work on 'ad' as a prefix and to look at words where /t/ and /d/ were followed by both bilabials and velars. Did he say 'upmost' or 'oupboard motor'? This was after all the same chap who thought there was a metal called 'tim' because the biscuits were kept in a 'tim box'(p. viii).

Let's look at assimilation in more detail. The alveolar phonemes /d/ /t/ and /n/ are very prone to change as John's case admirably shows. Firstly, when followed by any bilabial phoneme (/p/, /b/ and /m/) the alveolar phonemes are likely to sound as follows:

/t/ assimilates forward to become /p/

/d/ assimilates forward to become /b/

/n/ assimilates forward to become /m/

So, let's look at some examples of this:

/t/ assimilates forward to become /p/ for example 'that ... man' sounds more like ðæp mæn (think also within the word of 'bæpmæn')

/d/ assimilates forward to become /b/ for example, "admiral' or consider 'bad... boy' sounds more like bæb bɔɪ

/n/ assimilates forward to become /m/ for example "can ... break' sounds more like kæm bɹeɪk. A really interesting one is 'handbrake'... doesn't it sound more like 'ham break' – sandwich time?). Here a double switch is happening as the /n/ > /m/ and the /d/ assimilates with the /b/ of brake... Think also of words with the prefix un – unpopular, unbiased, unboxed... This indicates that focused work on the morphological units in the word (root + prefix) could be a useful approach. This is also an approach that focuses upon units of meaning, rather than units of sound.

Secondly, when followed by a velar phoneme the alveolar phonemes /d/ /t/ and /n/ are prone to change but whereas in the examples we have just looked at the sounds move forward when assimilated, in this case they move backwards. So /d/ is likely to sound like /g/ so 'good... game' sounds like gʊg gæm. Similarly /t/ is likely to sounds like /k/ so 'white ... cat' sounds like waɪk kæt. This also explains spellings such as 'bangk' because the /n/ assimilates backwards to become/ ŋ/ - the sound is really there – most of us just screen it out as we know how to spell the word conventionally.

This is why structured literacy programmes such as Alpha to Omega (Hornsby & Shear, 1993) that has its origins in speech therapy practice, spends so much time on word patterns containing nasal sounds. If you say these words aloud, you can hear how reduced the nasal sounds are. Try saying them paired with the word that would exist without the nasal e.g. 'sand...sad', 'damp.... dap' – this demonstrates that the nasals don't just like to assimilate, *they subtly alter the preceding vowel sound as well*. A learner sensitive to sounds will hear this difference and find it hard to understand that the same symbol represents both sounds. Another aspect that is useful to know about is coalescent assimilation. This partly explains the enormous trouble that some learners have with the phoneme /j/. How could anyone ever muddle /j/ with /ʃ/ or /ʒ/ - seems a fair enough question, doesn't it? But try saying 'six yawns' or 'this yawn' or 'coz you're worth it' – what happens? The /j/ changes doesn't it?

Summary

In this lecture we have looked at the influence that speech dynamics can have upon learners' spelling representation. We have also touched upon the possible contribution that some learners' atypical perception of vowels and consonants can make to spelling. Ironically, this amounts to some learners actually hearing more nuances within speech than the rest of us who routinely screen out those nuances. Knowing more about these areas gives us a more systematic way of analysing spelling performance and begins to give us more insight into the spelling of single syllable words and short phrases. Some of the aspects of speech dynamics also begin to explain more advanced spelling errors in polysyllabic words too. However, the representation of vowel sounds within polysyllabic words and the spelling of polysyllabic words more generally, are large topics in their own right and beyond the scope of this lecture.

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