ADDITIONAL RESOURCES

accompanying Dr Susan Galletly's presentation:

Session Monday 11.05am C4.11

Optimising Cognitive Load & Cognitive Processing for At-Risk & Struggling Readers

SEPLA-CON 2023 Conference

Change, Challenge and Choice

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What are these major players: Cognitive Load and Cognitive Processing?

- Cognitive load = the amount we have to think on and process at any one time, and over time.
- Cognitive-processing = the skills we use in thinking about and processing information.
- Cognitive load and cognitive processing work in tandem:
    - Easy learning creates low demands for efficient cognitive processing.
    - Complex learning creates high demands.

Let's Reflect-Respect-Respond

1. Reflect: Consider orthographic impacts and research

2. Respect: Be aware of the high cognitive load our children struggle with.

3. Respond: Consider ways forward (a) Currently (b) In the future

Useful Reads on the Research on Cognitive Processing and Cognitive Load impacts

- Knight & Galletly (2020). *Practical school-level implications of cognitive processing and cognitive load.*
- Tours 10, 11 & 12 of Galletly (2023b) *The Research Tours: The Impacts of Orthographic Disadvantage.*
    - Tour 10: A Multiple Deficits Vs Phonological Basis.
    - Tour 11: Executive-Function Skills Empower Word-Reading.
    - Tour 12: Our Impeded Statistical Learning
- Knight, Galletly & Gargett (2017a). *Managing cognitive load as the key to literacy development: Research directions suggested by crosslinguistic research and research on Initial Teaching Alphabet (i.t.a.).*
- Knight, Galletly & Gargett (2017b). *Principles of reading instruction towards optimising reading instruction for at-risk readers in Prep to Year 3: Reading Theory into Classroom Practice'.*

Useful Reads on the Research on Crosslinguistic Differences & Orthographic Impacts

- Galletly (2023b) *The Research Tours: The Impacts of Orthographic Disadvantage.*
- Galletly (2023a) *Poster & Resource Sheets: The High Cost of Orthographic Disadvantage.* Speech Pathology Australia 2023 national conference, Reflect-Respect-Respond, Hobart, 21-24 May, 2023. 1-18.
- Knight, Galletly & Gargett (2017a). *Managing cognitive load as the key to literacy development: Research directions suggested by crosslinguistic research and research on Initial Teaching Alphabet (i.t.a.).*

English readers need strong cognitive-processing skills

- Research on cognitive processing is proliferating exponentially.
- English readers with language impairment and children with reading-writing difficulties have significantly lower skills in
    - Short-term and/or working memory skills.
    - Statistical learning and self-teaching skills.
    - Executive-function skills.
    - Other cognitive-processing skills, e.g., phonological and phonemic awareness.

(Arciuli, 2017; Catts & Petscher, 2018; Diamond, 2013; Garon et al., 2013; Jacob & Parkinson, 2015; Knight & Galletly, 2020; Knight, Galletly & Gargett, 2017a; Krzysztof et al., 2018; Lemons et al., 2010; Marton et al., 2014; Meltzer, 2013; Michaelides & Luciano, 2023; Morgan et al., 2019; Ozeri-Rotstain et al., 2020; Plante & Gómez, 2018; Ricketts et al., 2011; Sawi & Rueckl, 2018; Schiff & Vakil, 2015; Tomas & Vissers, 2019; Wasserman & Wasserman, 2013).

Orthographic differences create major differences

- English readers weak at these skills tend to develop word-reading, spelling and literacy struggles.
    - Regular-orthography readers weak at these skills develop accurate word-reading and spelling.
- If Finland has 23 spelling patterns, Italian has 33, and English has well over 500, clearly there are huge differences in how easy and quickly children learn to read and write, and the cognitive load experienced by developing readers and writers.
- High cognitive load impacts Australian children across the years it takes to become skilled, confident readers and writers.

Why? Cognitive Load and Cognitive Processing Skills!

English orthography

- Creates high cognitive load.
- Thus needs for healthy cognitive processing skills
- Across the many years it takes to master word-reading and writing.

Regular-orthographies

- Have very low cognitive load.
- Are easy and gentle to master.
- Are quickly mastered in weeks to months.

Major factors include

- Orthographic complexity.
- Associated cognitive load across learning to read and write
- Needs for effective cognitive processing are major factors.

Having a single orthographic grainsize creates low cognitive load and low demands for effective cognitive processing

Regular orthographies use a single orthographic grain-size: phonemes and its single strategy: sounding-out. Doing so, regular orthographies create

1. Low cognitive load and
2. Low needs for effective cognitive processing

for beginning and developing readers when

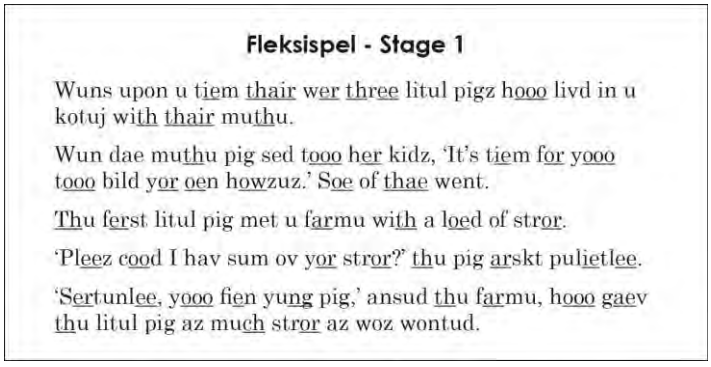
1. Learning to read and write
2. Reading and writing as they learn.

It's the opposite for highly complex English

The Low Cognitive Load of Learning to Read A Regular Orthography

Fleksispel, a fully-regular English beginners' orthography.

The curriculum: Learn your letter sounds, learn how to sound out to read words, and to list sounds to write words. When that learning is complete, build fluency over time, using self-teaching.



Fleksispel - Stage 1

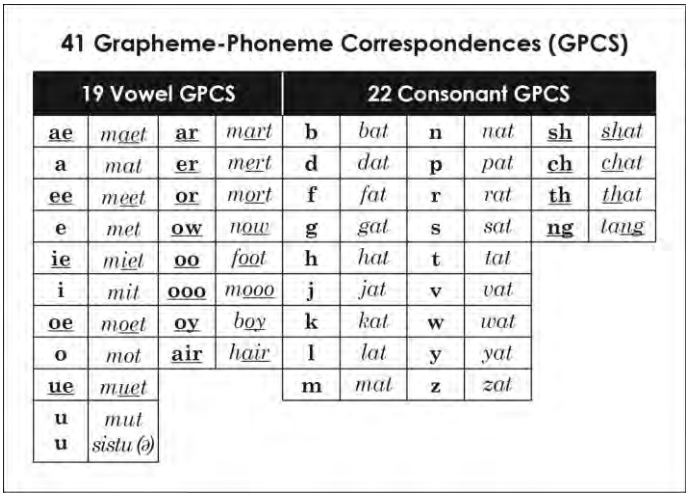
Wuns upon u tiem thair wer three litul pigz hooo livd in u kotuj with thair muthu.

Wun dae muthu pig sed tooo her kidz, 'It's tiem for yooo tooo bild yor oen howzuz.' Soe of thae went.

Thu ferst litul pig met u farmu with a loed of stror.

'Pleez cood I hav sum ov yor stror?' thu pig arskt pulietlee.

'Sertunlee, yooo fien yung pig,' ansud thu farmu, hooo gaev thu litul pig az much stror az woz wontud.



41 Grapheme-Phoneme Correspondences (GPCS)

19 Vowel GPCS				22 Consonant GPCS					
ae	*maet*	**ar**	*mart*	**b**	*bat*	**n**	*nat*	**sh**	*shat*
a	*mat*	**er**	*mert*	**d**	*dat*	**p**	*pat*	**ch**	*chat*
ee	*meet*	**or**	*mort*	**f**	*fat*	**r**	*rat*	**th**	*that*
e	*met*	**ow**	*now*	**g**	*gat*	**s**	*sat*	**ng**	*tang*
ie	*miet*	**oo**	*foot*	**h**	*hat*	**t**	*tat*		
i	*mit*	**ooo**	*mooo*	**j**	*jat*	**v**	*vat*		
oe	*moet*	**oy**	*boy*	**k**	*kat*	**w**	*wat*		
o	*mot*	**air**	*hair*	**l**	*lat*	**y**	*yat*		
ue	*muet*			**m**	*mat*	**z**	*zat*		
u	*mut*								
u	*sistu (ə)*								

Figures. Text using Stage-1 Fleksispel, and Stage-1 GPCs (Galletly, 2022, 2023a)

Our children need the Big 3 Executive-Function Skills

- The three overarching executive function skills:
    - Inhibition Control
    - Cognitive Flexibility
    - Working Memory
- All three are much needed for learning to read and write English.
- They're far less essential for regular-orthography children.

(Galletly, 2023; Knight & Galletly, 2020)

Executive Functioning is essential for social, occupational and academic functioning, physical and mental health and quality of life, and comprises top-down neuropsychological functions such as inhibition (of behaviour, attention or cognition in order to achieve a goal), shifting (changing internal perspectives or adjusting behaviour to new demands), and working memory, that is, mentally manipulating information held in mind (Diamond, 2013). Built on these domains, higher-order executive processes (problem-solving and planning) underpin decision-making and behaviour.

Christoforou et al., (2023)

Excerpt from Knight & Galletly (2020)

'***Executive functioning is a strong focus of research in diverse areas of child development, including***

- *Social behaviour, including self-control, self-regulation, anxiety and emotion regulation (Guhn, Gadermann, Almas, Schonert-Reichl, & Hertzman, 2016; Pimperton & Nation, 2014).*
- *Attention and distractibility, notably Attention Deficit/Hyperactivity Disorder (AD/HD), an executive function disorder (Barkley, 1997; Crippa et al., 2015).*
- *The role of working memory in reading and academic difficulties (Cirino et al., 2018; Compton et al., 2012; Gathercole & Alloway, 2008; Gathercole & Pickering, 2000, 2001).*
- *The separate and overlapping executive function profiles of different developmental disorders, e.g., AD/HD, Autism Spectrum Disorder (ASD), Speech-Language Impairment (SLI), dyslexia and reading disability, mathematics disability, developmental coordination disorder, and behaviour disorders (Alloway, 2011; Galletly & Knight, 2011a; Gathercole & Alloway, 2008; Nicolson & Fawcett, 2007).*
- *The discrete and interacting aspects of different cognitive-processing skills, e.g., verbal and visual-spatial short-term and working memory, executive-function skills, phonological and phonemic awareness, processing speed and Rapid Automotive Naming (RAN), and visual processing skills (Diamond, 2013; Koponen et al., 2013; Rabipour & Raz, 2012).*
- *Specific brain areas associated with specific aspects of reading and executive functioning (Arbel & Donchin, 2014; Bathelt et al., 2018; Lemons et al., 2010; Rueckl et al., 2015; Sawi & Rueckl, 2018).*
- *Interventions to overcome executive function weaknesses (Alloway et al., 2008; Diamond, 2013; Dunning, Holmes, & Gathercole, 2013; Rabipour & Raz, 2012).*'

Research Is Still Working Out How to Measure Cognitive Load

We don't yet have established efficient ways to measure the cognitive load people experience:

'*[While neurobiological correlates provide evidence for executive-function challenges in weak readers],* ***an online cognitive load detection mechanism has yet to be developed****. Nevertheless, eye-movement tracking can provide online data …*'

Ozeri-Rotstain et al., 2020

But We're Getting There: Next decades will be exciting in neuroscience

The measures and interventions we'll use, in single or integrated form (Knight & Galletly, 2020):

Boosting Cognitive Processing: In addition to sole interventions, there seem options of multiple pronged interventions being developed. For example, combining computerised interventions with options such as Event-Related Potential (ERP) and fMRI brain mapping (Molfese et al., 2010; Preston et al., 2016), Transcranial Direct Current Stimulation (tDCS; Au et al., 2016; Shin, Foerster, & Nitsche, 2015), physiological measures of cognitive load (Zagermann, Pfeil, & Reiterer, 2016), and use of medications such as those for managing attention difficulties (Diamond, 2013; Rabipour & Raz, 2012). With recent studies showing value in factors as diverse as self-talk empowering learning, saying words aloud enhancing vocabulary development, and sleep consolidating learning (Durrant et al., 2011; Ehri, 2014; Schiff & Vakil, 2015), it's likely that over time, the range of associated useful factors will expand.

Reading and Literacy are Key Areas to Study Cognitive Processing and Cognitive Load:

- We can consider cognitive load and cognitive processing by taking different view points
    - Comparing skill levels achieved by children with high vs low cognitive processing, and the length of time it takes to master skills.
    - Considering the impacts of deliberately raising cognitive load.
    - Using physiological measures.
- Word-reading, language skills & reading comprehension are key areas to study these impacts.

  "Reading texts is a complex skill involving actioning and integrating multiple perceptual and cognitive processes, and diverse brain areas. Texts' words are processed visually, then matched to phonological, orthographic, and semantic representations to build integrated understanding of texts' clear and subtle meanings. The more complex the text, the higher its cognitive demands. For beginning and struggling Anglophone readers, these demands are often extremely high."

  Knight & Galletly, 2020

- Crosslinguistic differences in orthographic complexity show high versus low cognitive load and needs for cognitive processing:
    - Regular-orthography nations: Children learning to read and write regular orthographies experience low cognitive load across early-literacy skill development, and take only months to reach adult proficiency.

- Anglophone nations: Children learning to read and write English experience high cognitive load across their many years of early-literacy skill development.

- We've our long sad tail of underachievers that regular-orthography nations don't have.
  - It's evident in word-reading studies, e.g., .
  - It's evident when we compare writing samples.

(Aro, 2004, 2017a, 2017b; Galletly, 2022, 2023, In press; Galletly & Knight, 2004, 2011a, 2011b, 2013; Knight & Galletly, 2017; Knight, Galletly & Aprile, 2021; Knight, Galletly & Gargett, 2017a, 2019)

Research studies show major crosslinguistic orthographic-impact contrasts:

- Word-reading acquisition across nations (Seymour et al., 2003)
- Reading mastery by children with Down Syndrome, who have intellectual disability and particularly low working memory (Cossu et al., 1993; Groen et al., 2006).
- The skill levels of Anglophone vs. regular-orthography weak word-readers (Landerl et al., 1997, Lyytinen, 2023; Lyytinen et al., 2021).

	REGULAR-ORTHOGRAPHY COHORTS	STANDARD ENGLISH COHORTS
Word-Reading in 14 European Nations (Seymour et al., 2003) [Tour 1]	Children in 10 nations: 90-98% accuracy at End-Grade-1 (and probably much earlier)	UK cohorts: Only 31% accuracy End-Grade-1 Only 69% accuracy End-Grade-2
Italian Vs English Readers with Down Syndrome (Cossu et al., 1993; Groen et al., 2006) [Tour 4]	High word-reading accuracy: 94% real words, 88% unfamiliar words. Difficulty finding subjects who weren't already highly accurate	One child reading well. Most at low level, and 30% of control group omitted, as unable to score on tests. Lists other studies showing similarly.
German Vs English Weak (Dyslexic) Readers (Landerl, Wimmer & Frith, 1997) [Tour 13]	Highly accurate reading of both real words and unfamiliar words. Few vowel errors.	Severely weak word-reading, with many at very low levels. 16 times more vowel errors.
Word-Reading Interventions Finnish Vs English Readers (Lyytinen, 2023, Lyytinen et al., 2021; Torgesen et al., 1997) [Tour 14]	Most children highly accurate by Grade 2, those with more severe difficulties by Grade 4-5.	With intensive ongoing intervention, most children make gains, but not to age-level, while some make little to no progress.

Cossu's insights on the role of working memory and intelligence in learning to read

Excerpt from The Research Tours (Galletly, 2023):

'Giuseppe Cossu and his team show this gentle, easy word-reading development in their research on Italian children with Down Syndrome learning to read (Cossu et al.,1993, Cossu, 1999).

The children they studied had severe intellectual disability (mean IQ of 44 and IQ range of 40 to 56), but mastered word-reading relatively easily, correctly reading 93.8 % of real words, and 88% of pseudowords, which were used to test reading of unfamiliar words.

Speaking with Professor Cossu when our CQU team visited researchers and schools in Italy, one big challenge in setting up the study was finding children with Down Syndrome who weren't yet

reading well, because word-reading development happens quite easily for Italian children with intellectual disability.

In common with other crosslinguistic researchers (e.g., Jimenez et al., 2003), Cossu (1999) concludes that general intelligence and working memory aren't pivotal for the acquisition of Italian word-reading, a statement that could never be made of English:

Whatever impairments the children with Down's Syndrome undoubtably show … these deficits have not precluded the children from acquiring the transcoding skills involved in reading. … despite a mean IQ of 44, these children read (regular words, irregular words and nonwords) with the same proficiency as normal Italian 7 year olds.

The children were older, with an age range from 8.0 to 15.8 years, but to be reading with Italian 7-year-old proficiency is simply brilliant by our standards, because 7-year-old Italian readers are virtually fully accurate, just not yet super speedy.

The study also clearly demonstrates how working memory and intelligence aren't big requirements for learning to read a regular-orthography, because that learning has such low cognitive load (Cossu, 1999):

Since a transparent orthography is mastered with no special effort by normal children, it is not surprising that even [intellectually disabled] children can easily grasp the orthographic principles and become efficient readers and writers (qua decoders).
This particular condition shows that general intelligence, verbal memory or psycho-motor skills are largely irrelevant factors for the acquisition of literacy.

Reading that statement in the early 2000s caused our CQU team to realise just how paradigmatically different Anglophone and regular-orthography worlds are.'

It's Orthographic Advantage Versus Orthographic Disadvantage

Galletly Poster & Resource Sheets (Monday lunch-time session) discusses research on this area.

Orthographic Impacts	Regular-Orthography! Awesome Foursome	Anglophone Nations! Awful Foursome
Early Literacy Development	• Easy & Rapid • Low Cognitive Load	• Difficult & Slow • Massive Cognitive Load
Teaching & Learning	• Minimal Difficulties • Maximised Literacy	• Maximised Difficulties • Impeded Literacy
School Impacts	• Time-Rich • Low Support Needs	• Very Time-Poor • Very High Support Needs
Academic Learning	• Empowered Subject Learning	• Impeded Subject Learning

Does Our Severe Orthographic Disadvantage Include Heightened Language Weakness?

- Hayiou-Thomas et al. (2004) showed that increasing cognitive load for Grade 1 & 2 UK children with healthy language skills induced patterns of language disorder, i.e., error patterns often seen in children with Language Disorder, but not seen in healthy-progress children.
- Orthographic disadvantage includes particularly high cognitive load across our children's years of early-literacy development.
- We need research exploring this area.

Acquired Helplessness quite likely compounds our children's difficulties

Maier & Seligman's revised Learned Helplessness theory has major implications re successful and unsuccessful learning (Knight & Galletly, 2020):

Acquired helplessness is not learned, but instead an automatic default path when success is averted, and failure, stress and difficulties are experienced.

(Galletly, 2023; Knight & Galletly, 2017, 2020; Knight et al., 2017a, 2019; Maier & Seligman, 1976, 2016;)

Useful Models for Considering Cognitive Load Impacts: Transition from Early to Sophisticated Literacy (TESL) and Differential Disadvantage Models

- Galletly (2023) The Research Tours: The Impacts of Orthographic Disadvantage
- Galletly & Knight (2011a). Differential disadvantage of Anglophone weak readers due to English orthographic complexity and cognitive processing weakness.
    - Adapted model in The Research Tours (Galletly, 2023).
- Galletly & Knight (2011b). Transition from Early to Sophisticated Literacy (TESL) as a factor in cross-national achievement differences.
- Galletly & Knight (2013). Because trucks aren't bicycles: Orthographic complexity as an important variable in reading research.

English Readers with Language Weakness Experience Differentially Heightened Disadvantage

Excerpt from Galletly (2023b) *The Research Tours*

'Elsewhere, we've proposed a model of differential disadvantage due to cognitive-processing weakness and the high cognitive load of learning to read and write Standard English (Galletly & Knight, 2011a). It takes automisation weakness and comorbidities into account, and also the non-automised skills of comorbidities.

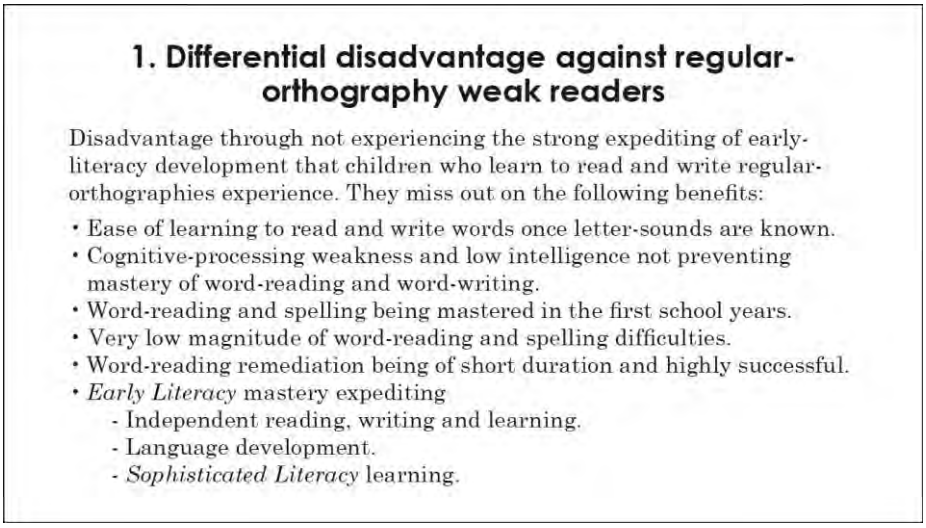


Figure 17a. Model of Differential Disadvantage of Anglophone children: Part 1: Disadvantage against regular-orthography weak readers (Galletly & Knight, 2011a, adapted)

As proposed in Part 1 of the model, above, all Anglophone weak readers are severely disadvantaged relative to regular-orthography weak readers because they miss out on the many benefits of regular-orthographies, and reading and writing being easily acquired skills.

The disadvantage is considerably more major for at-risk children. As shown in Part 2, those starting school with pre-existing language weakness, including cognitive-processing weakness, experience much greater disadvantage relative to their peers, because their early language-skills weakness more severely impedes literacy development and language development across the school years.

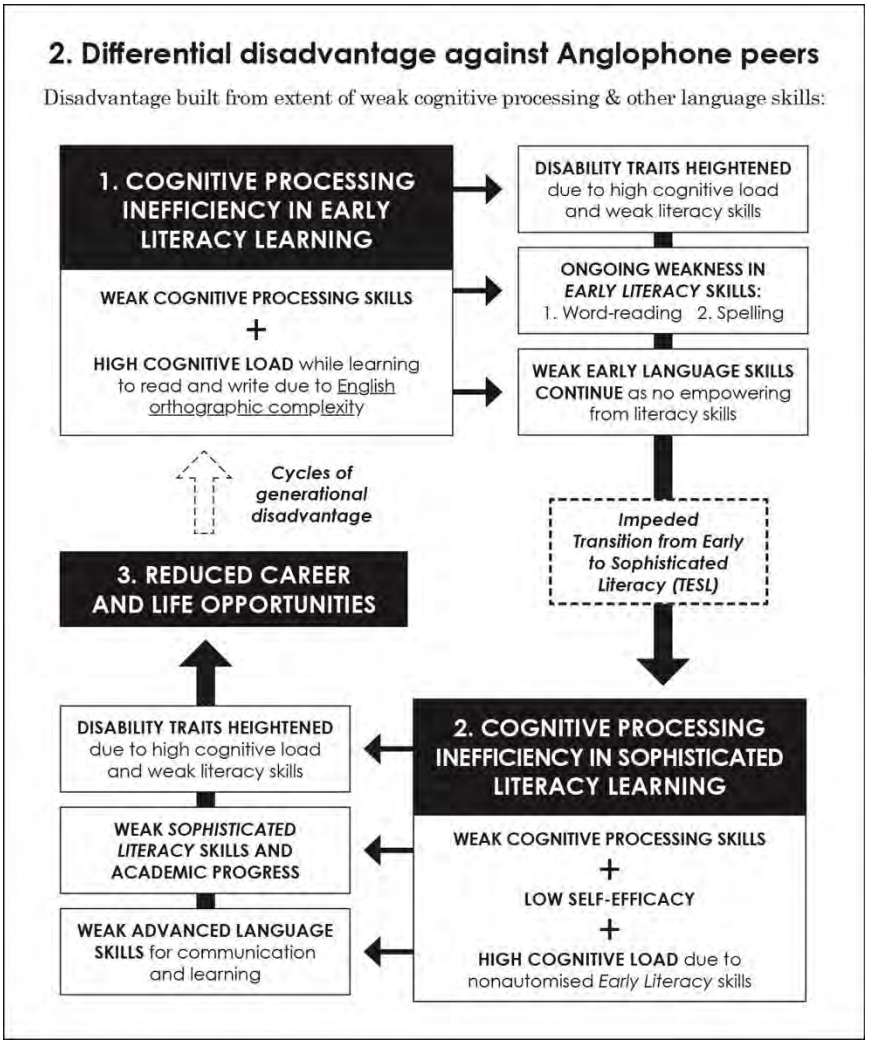


Figure 17b. Model of Differential Disadvantage of Anglophone children, Part 2: Disadvantage relative to Standard-English peers (Galletly & Knight, 2011a, adapted)'

TESL Intimates the High Cognitive Load of Insufficiently Developed Word-Reading and Spelling Skills

- Transition from Early to Sophisticated Literacy (TESL, Galletly & Knight, 2011b) is a key crosslinguistic difference, impacting cognitive load across literacy and learning
- Regular-orthography children can sequentially learn to read and write then read and write to learn because they are so quickly confident skilled independent reading and writing.
- English-readers must read and write to learn while they're still learning to read and write, because it takes so many years for word-reading and spelling to reach a high level, e.g., test norms show 6-9 years, on average.

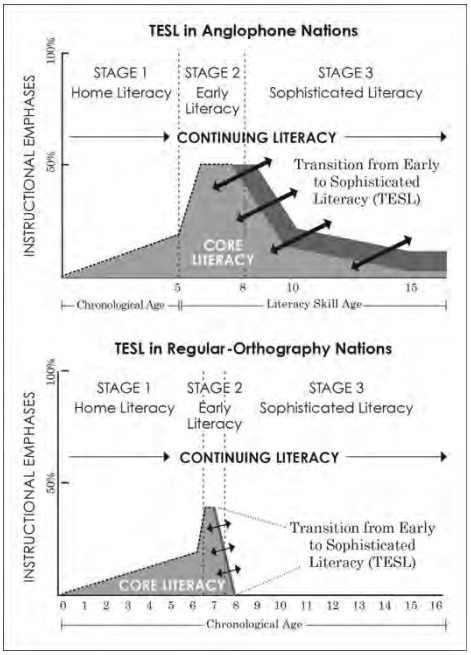


Figure. Transition from Early to Sophisticated Literacy (TESL) for Standard-English and regular-orthography readers (Galletly & Knight, 2011b, Knight et al., 2017a, 2019)

Respond: Consider ways forward
(a) Currently (b) In the future

- Let's encourage research on the impacts of cognitive load on our children
- Let's use strategies for managing cognitive load

Future Research May Include the 10 Changes

- Change 8 reduces cognitive load and needs for cognitive-processing skills.
- Change 9 increases children's cognitive processing skills.
- Change 10 emphasises needs to research these areas.

Change 8: *Investigate the potential of fully-regular beginners' orthographies: Research shows they're key. (Role-models: Taiwan, Japan & China changed to 2-Stage early literacy in the 1940s-50s)*

Change 9: *First, play to learn: Start Standard English word-reading instruction from mid-Year 2. (Role models: The many European nations where children are 7-8 years old in Grade 1).*

Change 10: *Build needed research knowledge as quickly as possible: Use collaborative school-based research.*

Features of Useful Strategies

- Having low cognitive load so children's processing capacity (working memory) is not overloaded.
- Helping children make progress quickly in multiple areas.
- Not being overly reliant on subskills that may not yet be automatic.
- Being simple to teach and easy to learn.
- Being easily made enjoyable and fun.

Strategies for managing cognitive load

- A huge area, e.g.,
    - I do 1 & 2 day seminars exploring this area.
    - We've a 10,000 word article on strategies written,
- Many detailed in Knight, Galletly & Gargett (2017b) *Principles of reading instruction* …
- Today: a few examples, focussed on school-aged children.
- In the conference resources file, I've included a powerpoint slides of a 1-day seminar exploring strategies.

Easing first draft writing

- Use speech to text software.
- Teach how to write spelling approximations.
- Build needed spoken language skills to a high level:
    - Synonym sentences
    - Narratives, persuasive texts
- Reduce demands for correct spelling: Make the Goal to *Get Your Fine Mind Down on Paper*
- Proofread 4 times (to expand working memory x 4)

Use Speech to Text Software

- This greatly reduces cognitive load.
- The language children use improves (opposite of Hayiou-Thomas' (2004) raising cognitive load).
- It's quick to write.
- Time saved means editing and honing work can be fun.

Teach Writing of Spelling Approximations.

- Teach writing of long words as phonemic equivalents.
- This empowers written vocabulary: '*You can write any word you can say!*'
- Build phonological awareness of syllables (e.g., Syllable Sleuthing, Sounds & Vowels, p. 62-64)
- Teach the *Rulz For Riting Big Words*
    1. Say the word by syllables on your fingers.
    2. Write syllable by syllable.
        (a) Flick a finger as you say the syllable.
        (b) Write it, & make sure it has a vowel
            (any vowel – no pressure re correctness).
    3. Check the word.
        (a) Count the vowels then
        (b) Read syllable by syllable, listening for sounds.

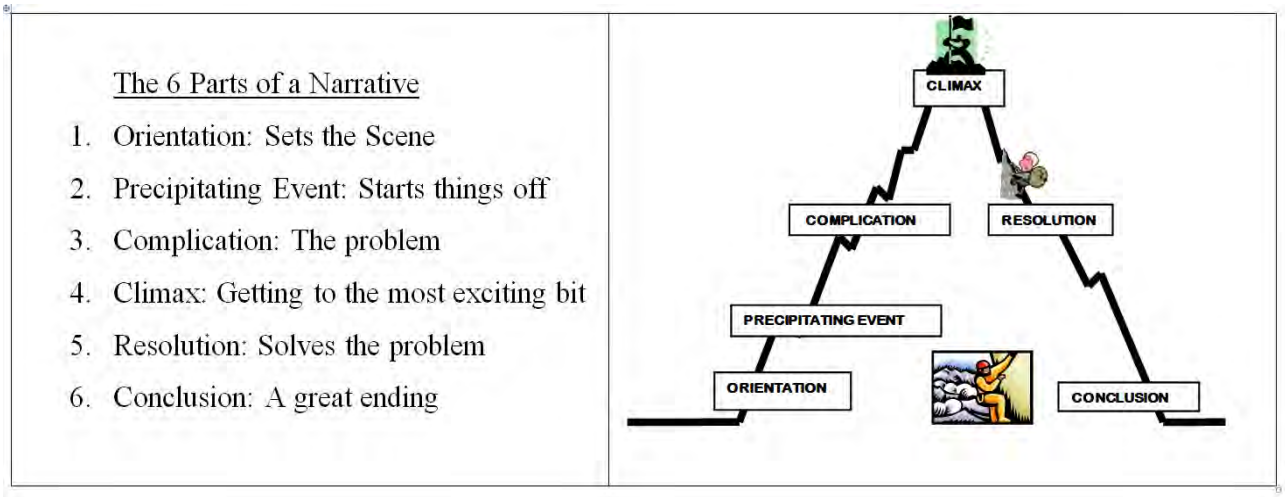
Not insisting spelling is correct is liberating and lowers cognitive load. Till skills & confidence build, any vowel will do: '*The duneso ate the reptu*' is much easier to read than '*The dns ate the rpt*'.

Build needed spoken language skills to a high level:

- Synonym sentences: Great for group work
    - Boring base sentence: *The little boy fell in the messy mud.*
    - Verbally play with options: *The tiny lad landed in the disgustingly messy mud.*

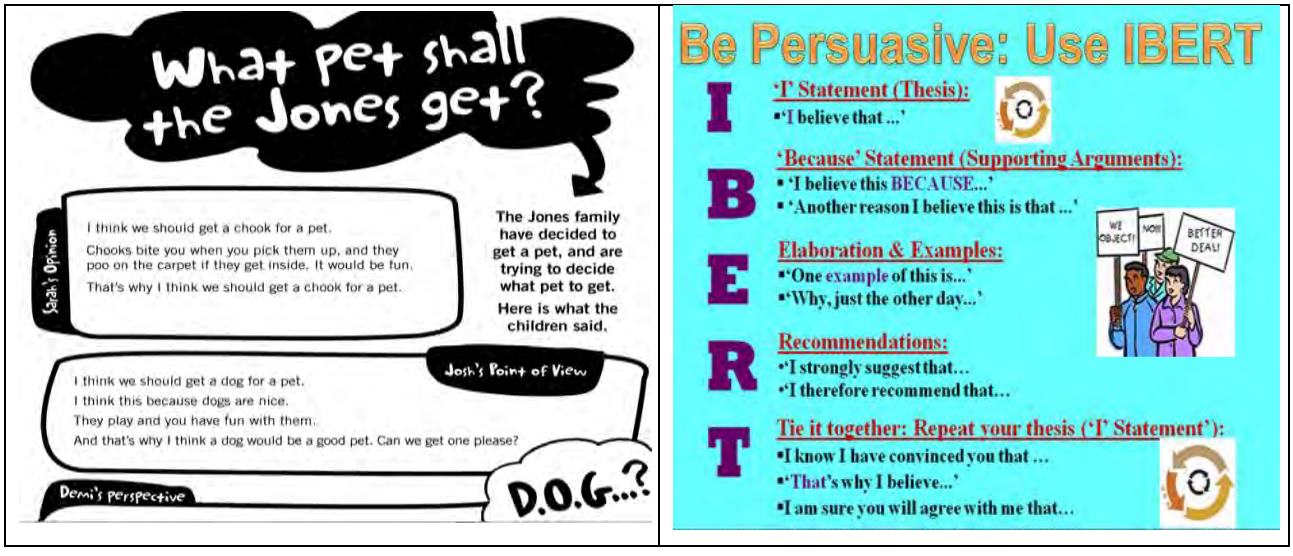
Narratives: Teach a 6-part narrative (6 paragraphs)

- Build skills for verbally telling a detailed narrative, e.g., practise one story (e.g., retelling *Little Red Riding Hood*) until expert.



Persuasive Text: Teach a 5-part IBERT

- Practice brief, informal, verbal persuasive texts till expert.



Reduce demands for correct spelling:

- The Rules:
    1) Spelling Doesn't Count in First Draft Writing.
    2) The Goal: Get Your Fine Mind Down on Paper
- Offer to correct all spelling mistakes, and watch writing improve.
- Combine this with teaching writing of spelling approximations
- This expands expressive vocabulary:
    - He got a ring, spelled correctly is nowhere near as good as
    - The yung man spleshd owt and bort a spektakula dimund ring.
- Make the Goal to Get Your Fine Mind Down on Paper

Proofread 4 times (to expand working memory x 4)

Use 4-step editing to reduce cognitive load and build skills & confidence

First two language-skill cycles then two editing cycles:

1.	M	My	Meaning
2.	G	Grandma's	Great words and sentences
3.	P	Pig	Punctuation
4.	S	Stinks	Spelling

Managing cognitive load makes a huge difference

When instruction and intervention is focused on keeping cognitive load at manageable level, practitioners will increasingly think of and develop useful high-gain strategies which keep cognitive load low, whilst building powerful skills used across multiple aspects of literacy.

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