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Evaluating the Potential of a Speech Rhythm-Based Reading Intervention

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PhD

June 2015

Coventry University

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A thesis submitted in partial fulfilment of the University's requirements for the Degree of Doctor of Philosophy

Abstract

A well established literature has demonstrated the contribution of segmental phonological awareness (i.e. awareness of the separable sound segments of spoken language) to reading, leading to the development of phonic-based interventions. However, despite good general evidence of effectiveness, not all children with reading difficulties respond to this approach to reading tuition. In addition, literature has largely ignored the potential contribution of suprasegmental phonology, which comprises the rhythmic components of language which accompany phonological awareness, such as linguistic stress, intonation and timing. Despite ongoing literature supporting a robust relationship between sensitivity to these rhythmic elements (particularly stress) and reading, there has to date been little reference to interventions based on training speech rhythm sensitivity in relation to literacy. This thesis therefore examines whether training on a speech rhythm-based intervention can benefit children's reading performance. In the first study, seventy-three reception children were randomly allocated to one of three groups, receiving either a speech rhythm-based intervention, a traditional phonological awareness-based intervention, or a control (maths-based) intervention over 10 weeks. All participating children were assessed on pre- and post-test measures of speech rhythm sensitivity, single word reading, phonological awareness and receptive vocabulary. Results illustrated that children exposed to the speech rhythm-based intervention made significant improvements in sensitivity to speech rhythm and single word reading performance compared to children in the control group. Additionally, there was no significant difference between the speech rhythm group and the phonological awareness group on their reading improvement between the pre- and post-test. In a second study, forty-nine 7-8 year-olds who performed below the expected level for a child in their age group on a standardised reading test were randomly allocated to receive either the speech rhythm-based intervention, a traditional phonological awareness-based intervention, or a control (semantic-based) intervention over 10 weeks. Participating children were assessed on pre- and post-test measures of speech rhythm sensitivity, single word reading, reading comprehension, phonological awareness and general IQ. Results showed that children exposed to the speech rhythm-based intervention made significant improvements in speech rhythm sensitivity and single word reading compared to children in the control group. Again, there was no significant difference between the speech rhythm group and the phonological awareness group on their improvement in reading between the pre- and post-test. Overall findings from these two longitudinal studies suggest that training on speech rhythm-based tasks has the ability to benefit children's reading performance at a level beyond that of a control intervention. However, no significant differences were found between the characteristics of children whose reading benefitted from exposure to the speech rhythm-based intervention and the characteristics of children whose reading benefitted from exposure to the phonological awareness-based intervention in either study, suggesting that there are no characteristics which can pre-determine the type of intervention a child will respond best to.

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Chapter 1: Theoretical Overview Part 1 – Theories of Reading and the Importance of Segmental Phonological Awareness

This thesis aimed to:

a. develop a set of speech rhythm-based training materials and activities suitable for use with both beginning readers (aged 4-5 years) and children aged 7-8 years who have already received some formal reading tuition but who may be struggling to meet the expected level of reading performance for their age;
b. formally evaluate the effectiveness of those training materials for improving the speech rhythm sensitivity, early reading skills and phonological awareness of beginning readers;
c. formally evaluate the effectiveness of the training materials for improving the speech rhythm sensitivity, single word reading, reading comprehension, and phonological awareness skills of a group of 7-8 year old struggling readers;
d. identify whether the characteristics of children whose reading skills improved as a consequence of exposure to the speech rhythm-based intervention were different from children whose reading skills improved as a result of phonological awareness training.

In order to construct a valid argument for the basis of these aims and the research questions later presented, a comprehensive review of the existing literature into reading development is presented. This argues the case for the importance of speech rhythm sensitivity in reading development, and also refers to more traditional ‘phonic’ based interventions that are used by educators in the UK and in many locations worldwide. As will be seen from the literature outlined below, whilst phonological awareness and phonic methods of reading tuition have been largely successful, they are not always effective for all children. In addition, the existing literature focusing on speech rhythm sensitivity has already demonstrated links between sensitivity to speech rhythm and reading attainment. In light of such literature, it is suggested that an intervention which is based on training children’s awareness of the rhythmic components of language could have the potential to contribute to successful reading performance on a level which is at least equivalent to traditional phonological methods.

1.1 Theories of Learning to Read

The aim of this section is to outline stages/phases in typical reading development, so that we can develop an understanding of where difficulties in reading may arise. Each theory will be discussed in detail, and the role of phonological awareness in reading development will be considered.

Reading is the process of being able to extract meaning from text (Nordquist, 2013), and the way in which this process develops has been characterised by a number of different theorists. Most theories of reading agree that successful reading development is dependent to some extent upon the development of phonological awareness (see Section 1.2). However, theories vary in the stages or phases that children are believed to progress through in the process of learning how to read.

Early reading theories such as that proposed by Gough and Hillinger (1980), Mason (1980), Marsh, Friedman, Welch and Desberg (1981), Chall (1983), Ehri and Wilce (1985) and Frith (1985) all acknowledged phonology in their proposed stages of learning to read. Frith, in particular, proposed a theory with three distinct stages which children had to proceed through in order to become skilled readers. Table 1.1 highlights the development and evolution of reading theories over time, illustrating the *stages* proposed by Gough and Hillinger (1980) and Frith (1985), and the *phases* proposed by Ehri (1995) and Ziegler and Goswami (2005).

Table 1.1 Stages and phases proposed in learning to read

Gough and Hillinger (1980)	**Frith (1985)**	**Ehri (1995)**	**Ziegler and Goswami (2005)**
	1. Logographic	1. Pre-alphabetic	1. Syllables
1. Cue reading		2. Partial alphabetic	2. Onset-rime
	2. Alphabetic	3. Full alphabetic	3. Nucleus-coda
2. Cipher reading		4. Consolidated alphabetic	4. Phoneme
	3. Orthographic		5. Phone

The first of Frith's stages was the 'logographic' stage, in which she proposed that children learn to recognise words based on their salient visual features; for example, recognising the word 'McDonalds' based on the 'M' logo. Secondly, Frith proposed that children progress through an 'alphabetic' stage, during which they begin to apply knowledge of phoneme-grapheme correspondences in order to identify and pronounce new or unfamiliar words. Here, children must use phonological awareness to identify individual letter-sound correspondences, and be able to blend these together to form words. Thirdly, Frith proposed an 'orthographic' stage, in which children become able to automatically and instantly recognise words in terms of their orthographic units. However, despite its influence, Frith's model encountered difficulties in accounting for the transition from one stage to another; Frith proposed that these stages of reading development followed a sequence in which one stage acts as a prerequisite to the next, and that only on completion of one stage can a child pass onto the subsequent stage. She proposed that each stage comprised two substages of reading and spelling, and that progression through these stages was dependent upon 'pacemaker' skills which allow strategies from one domain to be transferred to facilitate progression to the next stage. Frith explained that logographic reading acts as a pacemaker for logographic spelling; phonological awareness contributes to spelling in the alphabetic stage which acts as a pacemaker for alphabetic reading, and the orthographic representations gained through reading in the orthographic stage act as a pacemaker for orthographic spelling. Evidence in support of these ‘pacemaker’ skills comes from Wimmer, Landerl, Linortner and Hummer (1991), who found that the relationship between phonological awareness and early spelling ability was stronger than the relationship between phonological awareness and early reading, suggesting that awareness of phonology supports early spelling which in turn supports reading development. However, Frith also contends that it is not until the orthographic stage that children become able to memorise spellings, suggesting that recognition of letter sequences does not occur until the later stages of development. This notion is disputed by Goswami and Bryant (1990), who proposed that children are able to recognise spelling sequences much earlier in reading development, criticising the sequential nature of Frith’s theory.

Ehri (1992, 1995, 1997, 1999, 2002, 2005) disagreed with the fixed nature of Frith’s proposed stages, and instead developed a more flexible phase model of reading, building upon Frith’s stages and proposing 4 *phases* to reading development (see Table 1.1). Ehri’s phase theory proposed strategies for learning to read that could be employed in accordance with a child’s needs, knowledge, experience and ability level, meaning that development was not perceived as being fixed in a particular sequence of stages.

Instead of Frith’s ‘logographic’ stage, Ehri proposed a ‘pre-alphabetic’ phase, in which children learn to recognise words without any knowledge of their phonological properties. As with the logographic stage suggested by Frith, Ehri's pre-alphabetic phase focuses on being able to recognise words based on their visual or contextual features. This process is a precursor of alphabetic knowledge and occurs prior to the development of phonological awareness as children require no knowledge of sounds or letters to recognise common written words or symbols. Support for such a phase comes from studies such as that conducted by Masonheimer, Drum and Ehri (1984), who found that 3-5 year-olds with limited reading ability could identify signs, labels and logos that were presented with contextual cues. However, the ability of these children to 'read' signs and labels declined when the full context was removed from a word, and dropped dramatically when logos were also removed, highlighting the importance of contextual information in early word recognition. Masonheimer *et al*. also tested children's ability to detect subtle changes to the graphic information on labels and signs by altering one letter (e.g. spelling Pepsi as Xepsi). They found that that although children could identify approximately 60% of letter names, they were unable to detect these letter changes and continued to recognise the words as they were intended in their original form. This suggests that pre-readers rely more on the environmental or contextual visual features of words than printed letters, supporting the existence of a 'logographic' or 'pre-alphabetic' stage/phase in learning to read. The importance of context in reading is supported by Sheehy (1995), who developed a mnemonic approach to reading whereby visual cues are added to written text to represent the child's understanding of a given word. The cues, known as handles, act as a marker for recognition by adding idiosyncratic personal meanings to text, and are intended to trigger recall of the associated image, which in turn triggers recall of the associated word name. Sheehy (2002) concluded that applying this mnemonic element to a pictorial approach resulted in a greater number of words being recognised than with a ‘word alone’ approach. Sheehy and Holliman (2009) later concluded that evidence suggested that children with severe learning difficulties could be taught word recognition through the application of symbols in this way, supporting the importance of context. Sheehy and Holliman explained that evidence had suggested that the handle technique was effective due to the handles ‘non-pictioriality’, which allows it to mimic the salient visual feature which begins logographic recognition, supporting the role of visual features and cues in logographic reading, and further supporting the presence of the logographic stage in early word reading.

In contrast, Stuart and Coltheart (1988) presented evidence that not all children pass through the same sequence of stages in learning to read, and suggested that the relationship between phonological awareness and reading acquisition is bidirectional. Additionally, their data showed that phonological awareness could play a role in the very early stages of reading in phonologically adapt children, leading them to claim that it was neither visual nor contextual cues that facilitated reading development, and thus leading them to reject the presence of the logographic stage or pre-alphabetic phase. Instead, they suggested that successful reading development was purely dependent on phonological processing skills, supporting the role of phonological awareness in the alphabetic stage/phases.

Ehri’s phase theory sub-divided Frith’s second alphabetic stage into two sub-phases, claiming that children first develop partial alphabetic knowledge which is then followed by full alphabetic knowledge. Ehri proposed that during the partial alphabetic phase of reading, children begin to make connections between specific letters and sounds, using initial phonological awareness to identify letter-sound correspondences. Most commonly, children begin by focusing on the first and last letters of a word and begin to recognise common words based on those letters. Ehri believed that the presence of a pre-alphabetic phase was crucial to aid the development of phonological awareness as reading skills emerge, and suggested that this partial alphabetic phase emerges when children begin to acquire letter knowledge (Ehri, 2005:142). The presence of this partial-alphabetic phase is supported by Ehri and Wilce (1985), who questioned Gough and Hillinger's dismissal of such a phase. Ehri and Wilce (1985) allocated 48 kindergarteners to one of three groups, labelled as either pre-readers, novices or veterans dependent on the number of words they could read. Children were taught to read both simplified phonetic spellings where the letters corresponded to the sounds of the intended word (e.g. JRF for giraffe), and visual spellings where the letters bore no resemblance to the sounds, but were more distinctive visually. Participants were assessed for their ability to correctly recognise the words in each case. The results suggested that as children learn to read, they shift from processing visual cues to processing phonetic cues, supporting both the importance of visual information (as in the logographic, or pre-alphabetic stage/phase) and the emergence of phonological awareness (as in the partial-alphabetic phase), and contradicting the claims of Stuart and Coltheart (1988).

The third phase proposed by Ehri was the full alphabetic phase, which is similar to Frith's alphabetic stage. Ehri (2005) proposed that the full alphabetic phase emerges when children begin to acquire decoding ability and knowledge of the grapho-phonemic properties of language. Ehri (1999) claimed that it is during this phase that beginning readers develop the ability to form connections between graphemes in spellings and phonemes in speech in order to learn how to recognise and successfully read words. Indeed, Ehri and Wilce (1979) provided support for this grapheme-phoneme connection, finding that children who were asked to remember spoken words performed better when the words were accompanied by their written spellings. However, whilst this grapheme-phoneme identification strategy is effective for early word reading, it becomes less appropriate as reading develops because decoding words letter-by-letter requires good memory skills and is very time consuming. As reading develops, therefore, a more efficient strategy is employed whereby readers learn to identify clusters of letters.

This final stage/phase was labeled by Frith as the orthographic stage, and is consistent with Ehri's consolidated alphabetic phase. Ehri (2005: 150) claimed that "the consolidated alphabetic phase replaces the full alphabetic phase when the predominant types of connections for retaining sight words in memory are morphographic", suggesting that transition to this phase is dependent on morphological knowledge; for example, understanding morphological letter strings such as 'ing' and 'tion'. During this phase, Ehri proposed that patterns or clusters of letters become consolidated so that children can identify words by separating them into smaller, recognisable 'chunks'. In this way, words might also be broken down based on phonological units, such as onset, rime or coda. For example, the word 'string' might be processed as STR- (onset) and -ING (rime).

The term 'onset' refers to the consonants which precede the first vowel in a spoken syllable, and rime refers to a combination of the vowel and the consonants which follow it, for example in the word ‘cat’, the /k/ sound provides the onset, and the /at/ sound provides the rime component. It is important to note that this is a different term to ‘rhyme’, because, for example, as Goswami (2002) highlights, the words ‘mountain’ and ‘fountain’ rhyme, but each word contains two rime units of ‘ount’ and ‘ain’ because they have two syllables, whereas if we pair ‘mountain’ with ‘counting’, they still share a rime unit (‘ount’), but yet they do not rhyme.

As children become more familiar with grapheme-phoneme correspondences they learn that similar sounding words share the same patterns of letters, and children begin to form knowledge of these consolidated phonological units. For example, understanding ‘-ing’ as a single consolidated unit means that readers can identify it as a whole component rather than a series of grapho-phonemic units processed as ‘i-n-g’. This strategy is much more effective when children begin to read multisyllabic words. Indeed, Henry (2003) identified the difficulties surrounding decoding multisyllabic words, arguing that connections between written and spoken words are much more effective when the word is split into syllable units rather than individual phonemes.

Being able to break words down into their smaller components in this way is important for reading development, yet understanding of these different grain sizes has been somewhat overlooked in the theories discussed above. Ziegler and Goswami (2005) took this into consideration when they developed their ‘Grain Size Theory’, emphasising the importance of knowledge of various aspects of phonology in the development of reading skills. It is evident that where previous models of reading development had assumed that phonology worked alongside other abilities in the development of reading, Ziegler and Goswami's theory focused more on the importance of phonological awareness and the individual role of each grain. Ziegler and Goswami argued that in order to successfully process visual (orthographic) symbols and map them onto their corresponding sound (phonological) units, children need first to be able to identify 'grain sizes' between the two domains, beginning with the larger grains such as syllables and working towards knowledge of smaller grains over time. They highlighted that children encounter three main problems during this process, which relate to the availability, consistency and granularity of the language they are learning, and they claimed that reading ability ultimately depended on the ease with which children could overcome these barriers.

The issue with availability refers to the assumption that not all phonological units are accessible to beginning readers, meaning that they encounter problems linking the phonological properties of language to the corresponding orthographic features. Access to phonological representations is therefore only achieved as a result of letter sound knowledge and phonological awareness, which Ziegler and Goswami (2002) claimed is only achieved through direct tuition. They proposed that access to the larger grain sizes is achieved unaided in the earliest stages of reading, such that knowledge of syllables, onsets and rimes are represented prior to the acquisition of literacy skills. Smaller grain sizes such as phonemes are only represented through acquisition of alphabetic knowledge and literacy tuition (Ziegler and Goswami, 2002:144), suggesting that phonemic awareness develops only once children begin to learn to read. Controversially, Caravolas (2006) acknowledged evidence that phonemic awareness can be demonstrated prior to reading acquisition, suggesting that awareness of phonology develops before the onset of reading (e.g. see

Caravolas and Bruck, 1993). Caravolas concluded that the issue may therefore not be that phonemic information is unavailable to pre-readers, but that its availability depends on the language in which children are learning to read.

In addition, while some languages are fairly consistent in their connections between orthography and phonology, less consistent languages such as English contain instances where there are a number of different pronunciations for the same orthographic unit (e.g. ‘read’), and similarly, words that are pronounced the same can have a number of different spellings (e.g. there vs their; to vs too vs two; pear vs pair, etc). Ziegler and Goswami attempted to explain this in their grain size theory, suggesting that reading in consistent orthographies involved the use of small units (grains) of language, whereas reading in inconsistent orthographies requires the use of larger grain sizes.

They acknowledged that as grain sizes increase, there are more orthographic units to learn, i.e. there are more words than syllables, more syllables than rimes, more rimes than graphemes, and more graphemes than letters. Ziegler and Goswami suggested that children gain awareness of the different units of sound in order, progressing from awareness of large units (or grains) such as syllables to a deeper knowledge of phonology and awareness of the smallest units of sound (grains) such as phonemes (those that can signal differences in meaning) and phones (distinguishable sounds that are not related to meaning). This is consistent with Stanovich (1986; 1992) who supported the idea that knowledge of phonology progressed from shallow to deep awareness. However, this theory is challenged by evidence from Duncan, Seymour and Hill (1997), and Hulme (2002), who argued that development of reading skills progresses in the opposite direction, with awareness of the smallest units of sound being acquired first. Further issues regarding grain size theory were raised by Duncan, Seymour and Bolik (2007), who acknowledged that not all words can be classified as having an onset-rime structure, and that many disyllabic or multisyllabic words are better classified as having an onset-remainder structure, rather than having an onset and rime for each syllable. Duncan et al (2007) concluded that the complex nature of disyllabic or multisyllabic word reading has been neglected not only in grain size theory but in each of the theories of reading development discussed here, highlighting the fact that Frith (1985), Ehri (1995) and Ziegler and Goswami (2005) all focus on monosyllabic word reading in their theories of reading development, and disregard how children come to read multisyllabic words.

These theories, along with others in the literature (e.g. Gough and Hillinger, 1980.) have provided a strong theoretical basis for understanding reading acquisition and development. The consistent link to phonological awareness is apparent throughout the discussion of these theories, and this is a skill which has been repeatedly and robustly demonstrated to be related to reading development throughout the literature, and this will be discussed further in Section 1.2.

1.2 Segmental Phonological Awareness

The term phonology refers to the mental representation and processing of speech sounds, both in perception and in production (Ramus and Ahissar, 2012:3). The Oxford Dictionary defines phonology as “the study of the sound systems of languages”, with the word in its derived form coming from the Greek word phōnē, meaning voice or sound, and lógos, meaning word or discourse. Over the years, the idea that reading words requires awareness of phonology has ascended from a minority view to one with such a substantial majority that it now amounts to a conventional wisdom (Perfetti, 2011).

Phonological awareness refers to the ability to perceive and manipulate the sounds of spoken language (Goswami and Bryant, 1990). It has been defined by Konza (2011: 2) as the ability to focus on speech sounds rather than meaning, and has been described as a skill which has a direct influence on reading development (Bradley and Bryant, 1983). However, Castles and Coltheart (2004) questioned the causality of this relationship, reassessing the evidence that phonological awareness represents a skill specific to spoken language that precedes and directly influences the process of reading acquisition. They examined both longitudinal and experimental training studies, focusing primarily on the extent to which studies have controlled for existing literacy skills and the influence that these skills may have on phonological awareness. In doing so, Castles and Coltheart acknowledge that a number of theorists have raised the question as to whether phonological awareness influences literacy acquisition, whether literacy acquisition influences phonological awareness, or whether the two skills share a reciprocal causal relationship (e.g. see Perfetti, Beck, Bell and Hughes, 1987; Wagner, Torgesen and Rashotte, 1994). They argue that the documented association between phonological awareness and reading may not reflect a causal relationship in either direction, but instead may illustrate that once children acquire the ability to read and spell, the way in which they perform phonological awareness tasks alters to accommodate their newly acquired orthographic skills either in addition to, or in place of, existing phonological skills. Castles and Coltheart concluded that the causal link between phonological awareness and successful literacy acquisition remained unproven. However, Hulme, Snowling, Caravolas and Carroll (2005), in response to this paper, argued that a large balance of evidence does in fact support such a causal link. Hulme et al claimed that instead of simple associations between phonological awareness and literacy skills, the relationship should be seen in terms of a multi-causal system whereby learning to read depends on a multitude of broader language skills, including phonological awareness.

The term ‘phonological awareness’ refers not only to individual sounds, but also to sound combinations, individual words, rhyme and rhythm, thus incorporating numerous different elements. Phonological awareness can, as a result, be broken down into two distinct components (see Holliman, Wood and Sheehy, 2012), the first of which is referred to in this thesis and elsewhere as segmental phonological awareness. Until recently, the term ‘phonological awareness’ has been used almost exclusively in the reading literature to refer to knowledge of segmental phonology, and as a result, the second part of phonology, known as suprasegmental phonology, has been somewhat neglected, and this will be revisited in Chapter 2.

The smallest segment of sound that can signal differences in linguistic meaning is referred to as a phoneme (see Armbruster, Lehr & Osborn, 2003:2). Phonemes are typically those sounds which we represent as individual letters in English, for example the word ‘cat’ can be broken down into the individual phonemes of /k/ /a/ /t/. Throughout the English language, there are approximately 44 phonemes (see Table 1.2), with some variation dependent on accent and articulation (Bates, 2014). These phonemes are made up from the 26 letters of the English alphabet, either individually or in combination.

Table 1.2 Phonemes in the English language (adapted from the Dyslexia Reading Well, 2014)

Phoneme (sound)	**Grapheme(s) (spellings)**	**Example(s)**
Consonants		
/b/	b, bb	bug, bubble
/d/	d, dd, ed	dog, add, filled
/f/	f, ff, ph, gh, lf, ft	fan, cliff, phone, laugh, half, often
/g/	g, gg, gh, gu, gue	gap, egg, ghost, guest, catalogue
/h/	h, wh	hat, who
/j/	j, g, gg, ge, dge, di	jam, giraffe, exaggerate, cage, edge, soldier
/k/	k, c, ch, cc, q(u), ck, x, lk	kite, cat, Christmas, acclaim, queen, bouquet, back, box, talk
/l/	l, ll	leaf, spell

/m/	m, mm, mn, lm, mb	man, summer, autumn, climb, palm
/n/	n, nn, kn, gn, pn	net, funny, know, gnat, pneumonia
/p/	p, pp	pig, happy
/r/	r, rr, wr, rh	robot, carrot, wrong, rhyme
/s/	s, ss, c, ce, se, sc, ps, st	sun, less, circle, rice, horse, science, psychology, listen
/t/	t, tt, th, ed	tap, better, Thomas, tapped
/v/	v, ve, f, ph	van, five, of, Stephen
/w/	w, wh, u, o	web, why, quick, choir
/y/	y, i, j	yo-yo, opinion, hallelujah
/z/	z, zz, ze, s, ss, se, x	zebra, buzz, maze, has, scissors, cheese, xylophone
Digraphs		
/zh/	s, si, z	treasure, division, azure
/ch/	ch, tch, tu, ti, te	chip, watch, future, question, righteous
/sh/	sh, s, ce, sci, ci, si, ch, ti	shark, sure, ocean, conscience, special, tension, machine, station
/th/	th (voiced), th (unvoiced)	thing, feather
/ng/	ng, nk, ngue	ring, pink, tongue
Short Vowels		
/a/	a, ai, au	cat, plaid, laugh

/e/	e, ea, eo, ie, ei, ei, ai, a, ae u	end, bread, leopard, friend, heifer, said, many, aesthetic, bury
/i/	i, e, ie, o, u, ui, y	igloo, England, sieve, women, busy, build, hymn
/o/	o, a, ho	orange, swan, honest
/u/	u, o, oo, ou	mug, monkey, flood, double
/oo/	oo, u, ou, o	book, bush, could, wolf

Long Vowels

/ā/	ai, a, ei, eigh, aigh, ay, et, au, a-e, ea, ey	snail, baby, vein, weigh, straight, hay, croquet, gauge, cake, break, they
/ē/	ee, e, ea, y, ey, oe, ie, i, ei, eo, ay	bee, me, seat, lady, key, phoenix, brief, ski, receive, people, quay
/ī/	i, y, igh, ie, uy, ye, ai, is, eigh, i-e	spider, fly, night, pie, buy, rye, aisle, island, height, kite
/ō/	oa, o-e, o, oe, ow, ough, eau, oo, ew	boat, bone, open, toe, low, though, beau, brooch, sew
/ū/	oo, ew, ue, u-e, oe, ough, ui, o, oeu, ou	moon, screw, blue, flute, shoe, through, fruit, who, manoeuvre, croup
/y//ü/	u, you, ew, iew, yu, eue, eau, ieu, eu	unit, you, few, view, yule, queue, beautiful, adieu, feud
/oi/	oi, oy, uoy	coin, boy, bouy
/ow/	ow, ou, ough	cow, shout, bough

/ə/ (schwa)	er, ar, our, or, i, e, u, ur, re, eur	ladder, dollar, honour, doctor, dolphin, ticket, cactus, augur, centre, chauffeur
Controlled Vowels		
/ã/	air, are, ear, ere, eir, ayer	chair, square, wear, where, their, prayer
/ä/	ar, a, au, er, ear	car, bath (regional), laugh, sergeant, heart
/û/	ir, er, ur, ear, or, our, yr	bird, term, burn, pearl, word, journey, myrtle
/ô/	aw, a, or, oor, ore, oar, our, augh, ar, ough, au	paw, ball, fork, door, more, board, four, taught, war, bought, sauce
/ēə/	ear, eer, ere, ier	ear, steer, here, pier
/üə/	ure, our	cure, tourist

Over time, an extensive literature has demonstrated robust relationships between phonological awareness and literacy performance, with an awareness of phonemes being highlighted as being of particular importance. Foy and Mann (2001), for example, investigated how the strength of phonological representations could predict phonological awareness in pre-school children. They considered the aspects of spoken language that may contribute to the development of phonological awareness, examining rhyme awareness, phoneme awareness, articulatory skill, speech perception, vocabulary and letter-word knowledge in 40 children aged 4-6 years. Findings did not validate the strength of phonological representations as a unitary construct underlying phonological awareness, but instead revealed a multitude of associations between spoken language skills and aspects of phonological awareness, illustrating that speech perception was predictive of rhyme awareness, and that phoneme awareness was associated with phonological perception and production. It seems from these findings that there are a number of different ways in which individual phonological skills map on to phonological awareness.

Research by Duncan and Johnston (1999) examined phonological awareness and the reading of non-words in the later stages of reading development by comparing 11-year-old poor readers with their 8-year-old reading age matched controls. They found that phoneme awareness in particular correlated significantly with poor readers' word and non-word reading abilities. Furthermore, it was found that rhyming skills were not significantly correlated with reading, emphasising the importance of phoneme awareness over other components of phonology such as rhyme awareness.

Controversially, Goswami (1999) highlighted the potential importance of rhyme awareness in successful reading development, arguing that there is an array of research evidence supporting a causal relationship between rhyme awareness and reading. Goswami and Bryant (1990), for example, claimed that rhyme awareness has a direct influence on reading ability, and also has an indirect influence on phoneme awareness. This relationship was further examined by Macmillan (2002), who investigated claims such as those of Goswami and Bryant (1990) regarding the importance of rhyme awareness in successful reading acquisition and development. However, Macmillan concluded that there was not enough evidence to support these claims, and that evidence which does show rhyme awareness as a predictor of reading ability comes from studies with numerous methodological limitations. Furthermore, Macmillan also concluded that the relationship between phoneme awareness and reading may contribute to the assumption that children must be able to detect individual phonemes in order to learn how to read (Macmillan, 2002: 34). Phoneme awareness is therefore highlighted as having considerable importance in relation to reading development, and this is consistent with a large body of evidence supporting phonemic awareness as a significant predictor of reading (e.g. see Melby-Lervag, 2012).

In a recent meta-analysis, Melby-Lervag, Lyster and Hulme (2012) reviewed the relationships that have been found between children's phonemic awareness, rhyme awareness and verbal short term memory in a sample of 235 studies. Findings illustrated that children with dyslexia showed a large deficit in phoneme awareness compared to typically developing children of the same age, suggesting that poor phonological skills can map on to reading difficulties. Findings also revealed that phoneme awareness was the strongest correlate of reading development relative to other forms of segmental phonological awareness.

The robust relationship between segmental phonological awareness and reading has been demonstrated not only in British English and American English, but also in Hebrew (Russak and Saiegh-Haddad, 2011; Schiff, Schwartz-Nahshon and Nagar, 2011), Arabic (Taibah and Haynes, 2011), Chinese (Pan, McBride-Chang, Shu, Liu, Zhang and Li, 2011), Greek (Constantinidou and Stainthorp, 2009), and

Spanish (Carrillo, 1994; de Manrique and Signorini, 1994; Herrera, Lorenzo, Defior, Fernandez-Smith and Costa-Giomi, 2011).

The ongoing and widespread support for this relationship between segmental phonological awareness and reading performance led Fowler (1991) to suggest that well-specified phonological representations are important for the development of typical reading ability. This, in turn, leads to the conclusion that reading ability suffers partly as a consequence of poor segmental phonological awareness (e.g. see Snowling, 1981; Stanovich, 1986; Hulme and Snowling, 1992; Snowling, 2000). Indeed, children with reading difficulties have consistently been shown to display deficits in segmental phonological awareness (see Melby-Lervag, Lyster and Hulme, 2012). Snowling (1981) compared dyslexic and reading aged-matched controls on reading and speaking exercises. Findings showed that dyslexic individuals had more difficulty reading two syllable non-words than their reading age-matched controls, and that the relative difficulty of nonsense words over real words was also greater for the dyslexic group. Snowling concluded that dyslexic readers could be subject to general phonemic deficits which affect their ability to process both written and spoken words. More recently, Elbro and Jensen (2005) found that dyslexic individuals performed at a lower level than their reading age-matched controls on both non-word reading and phoneme awareness tasks, concluding that poorly specified phonological representations may be an underlying problem in dyslexia.

This link between reading difficulties and poor phonological awareness has been best explained by the phonological representations hypothesis (Snowling, 2000;

Stanovich, 1986), which states that developmental difficulties in reading are characterised by poor or underspecified phonological representations, implying that phonological deficits may be a core predictor of reading difficulties. This idea was initiated by Shankweiler (1964), who rejected the view of poor reading as a consequence of abnormalities in visual perception, and recognised the importance of phonemic awareness. This hypothesis has since been the dominant explanation favoured by researchers as to the possible cause of dyslexia (see Snowling, 2011), leading Stanovich (1986) to suggest that dyslexia should be defined in terms of a core phonological deficit. Torgesen and colleagues supported this suggestion, claiming that "perhaps the most important single conclusion about reading disabilities is that they are most commonly caused by weaknesses in the ability to process the phonological features of language" (Torgesen, Wagner, Rashotte, Rose, Lindamood, Conway and Garvan, 1999: 579). Castles and Coltheart (2004), as mentioned earlier, disagreed with this claim, concluding that the causal link between phonological awareness and successful reading acquisition remained unproven. Others, however, have argued that substantial evidence does support such a causal link (see Hulme, Snowling, Caravolas and Carroll, 2005). Indeed, Swan and Goswami (1997) found evidence that phonological awareness deficits in dyslexic children appeared to stem from problems in the encoding and/or the retrieval of phonological representations (Swan and Goswami, 1997: 37).

The British Dyslexia Association (2007) defines dyslexia as a specific learning difficulty that mainly affects the development of literacy and language related skills. They state that dyslexia is characterised by difficulties with phonological processing, rapid naming, working memory, processing speed, and the automatic development of skills that may not match up to an individual's other cognitive abilities. In addition, they claim that it tends to be resistant to conventional teaching methods, but that its effect can be mitigated by intervention.

Developmental dyslexia is now widely believed to be caused by a core phonological deficit (Snowling, 2000; Ramus, 2003). However, Uppstad and Tonnessen (2007) claimed that a definition of dyslexia should be based on symptoms and should not include causes such as a ‘phonological deficit’ because this limits the search for other possible contributing factors. Ramus and Ahissar (2012) identified that deficits have been found in a wide variety of tasks, leading to numerous theories of dyslexia. They highlighted that dyslexic individuals display poor performance not only in phonological awareness, but also in verbal short-term memory, working memory and rapid automatised naming. Indeed, Elbro (1998) raised the question as to whether a single phonological factor could explain many of the phonological deficits related to dyslexia, suggesting that indistinct phonological representations of lexical items in long term memory may be a unifying factor.

However, Nation and Snowling (2004) administered tests of oral language skills, phonological awareness and reading to 72 children aged 8-13 years, and concluded that broader language skills were also important in determining the ease with which children learn to read, and that the progress children make in reading is related to individual differences in both oral language skills and phonological awareness. It seems, therefore, that a variety of skills may contribute to successful reading acquisition and development. Richardson, Thomson, Scott and Goswami (2004) further acknowledged that although the causal connection between phonological skills and reading acquisition is well established, individual differences in auditory processing skills may also play a role. Richardson et al (2004) therefore administered a range of phonological, auditory, reading and spelling tasks to a group of 24 dyslexic children, 24 chronological age-matched controls and 17 reading age-matched controls. Findings showed that individual differences in performance on auditory tasks involving amplitude envelope cues (rise time; see Gosawmi et al, 2002) could explain a significant amount of unique variance in phonological processing skills. Furthermore, Stein (2001) claimed that auditory processing deficits could contribute to the poor phonological skills observed in participants with dyslexia, and suggested that we may be able to explain individual differences in reading through measuring their awareness of visual and auditory stimuli.

In an attempt to determine the range of deficits contributing to reading difficulties, Ramus, Rosen, Dakin, Day, Castellote, White and Frith (2003) conducted a multiple case study into developmental dyslexia, administering a variety of psychometric and phonological assessments to 16 university students with dyslexia. Data revealed that all 16 of the reading disabled participants suffered from a phonological deficit, whilst only some of these also suffered from additional auditory, visual or motor difficulties. Such findings suggest that it is possible for a phonological deficit to be present in the absence of any other sensory or motor difficulty. However, Thomas and Karmiloff-Smith (2005) argued that even those highly selective deficits in childhood may have severe effects on development such that it would be unlikely for a phonological deficit to emerge in isolation. In addition, Carroll and Snowling (2004) found that both children with speech difficulties and children with a family history of dyslexia showed similar patterns of impairment, suggesting that there may be some overlap between phonological deficits and speech difficulties. Carroll and Myers (2010), in addition, examined the extent of comorbidity between specific language impairment (SLI) and dyslexia, comparing 46 children with familial risk of dyslexia to 128 typically developing peers. Findings revealed that children with familial risk of dyslexia did not differ in severity or form from those shown by the other children. They argued that this relationship may be best explained in terms of Pennington's (2006) multi-deficit model. Pennington (2006) argued that cognitive models of dyslexia have often focused on a single cognitive cause (such as a phonological deficit) as the cause of dyslexia, and instead presented a multiple cognitive deficit model of developmental disorders which attempted to explain the comorbidities between dyslexia and attention deficit hyperactivity disorder (ADHD), and between dyslexia and speech sound disorder (SSD). Pennington highlights the overlap in difficulties, particularly between dyslexia and SSD, claiming that the phonological deficit first causes SSD and then later causes difficulties with reading. Ramus and Szenkovits (2008) further suggested that the phonological representations of people with dyslexia may in fact be intact, and that the phonological deficit may only surface as a function of certain task requirements such as short term memory, conscious awareness and time constraints.

In support for this, Blomert and Willems (2010) investigated the relationship between reading difficulties and poor phonological awareness in a sample of children in kindergarten and first grade with a familial risk of dyslexia. Although the familial risk was genuine, Blomert and Willems failed to demonstrate any relationship between phonological awareness and reading deficits. Similar findings were reported by Castles and Coltheart (2004), mentioned earlier, who concluded that no study had provided unequivocal evidence of a causal link between phonological awareness and successful reading acquisition. In addition, Cain, Oakhill and Bryant (2000) investigated the degree to which phonological processing deficits could account for difficulties in reading comprehension after controlling for word reading skills. In a number of experiments, both skilled and non-skilled comprehenders were tested on their reading abilities including tests of phonological awareness. Results showed that both those with good comprehension skills and those with poor comprehension skills performed similarly on measures of phonological processing, but that they differed on tasks requiring greater use of working memory. This suggests that reading problems may arise from higher level processing difficulties, which may not always be due to a phonological deficit.

It seems, therefore, that despite ongoing support for the relationship between phonological awareness and literacy development, this view of dyslexia and reading difficulties has come under a substantial amount of scrutiny due to evidence that reading problems may be rooted in more fundamental difficulties (see Elbro, 1998; Ramus and Szenkovits, 2008; Stein, 2001). Despite such controversy however, there is still a strong library of evidence supporting the link between phonological awareness and literacy outcomes. Indeed, Stanovich has claimed that the role of phonological processing in the earliest stages of reading acquisition is “one of the more notable scientific success stories” (Stanovich, 1991: 78), and Adams (1990) praised the discovery and documentation of the importance of phonemic awareness in reading development, describing it as the single most powerful advancement in the science and pedagogy of reading in the 20th Century.

Despite the emphasised importance of phonological awareness in reading, however, a key limitation of the existing literature on phonological skills and literacy development to date has been the tendency to almost exclusively focus on segmental phonological awareness. As a result of this focus, the potential contribution of suprasegmental phonological awareness has therefore often been overlooked, and the need to examine this second, less researched type of phonology will be examined later in this thesis.

It can, however, be suggested that if we are able to detect a deficit in phonological awareness early on, we should be able to adapt reading tuition to address this deficit and encourage reading acquisition to develop as successfully as possible. Such theory and research has led to the development of educational interventions which have focused on developing children’s awareness of segmental phonology and showing how these speech segments map onto text. Such interventions are commonly referred to as ‘phonic’ interventions, and are now incorporated into the teaching of reading skills in literacy classes worldwide.

1.3 Phonologically-Based Reading Interventions

Methods based on training phonological awareness have been the dominant approach to reading tuition for many years, and have been the subject of reading research studies spanning over a century (see Cameron, 1914; Dolch and Bloomster, 1937; Grupe, 1916; Rogers, 1938; Tiffin and McKinnis, 1940; Zirbes, 1924). There have been various attempts to create successful reading interventions using phonological training, and this type of tuition is now well established in commercially available packages. Most such programmes include not just phonological awareness training but also some tuition relating to how phonemes correspond to graphemes, and this type of intervention is commonly referred to as ‘phonics’.

Adams (1990: 31) claimed that programmes which include systematic instruction on letter-sound correspondences lead to higher achievement, especially in the early grades. A strong library of evidence supports this claim, illustrating that training on various phonic-based programmes has the ability to influence reading ability (e.g. Ehri, Nunes, Stahl and Willows, 2001). The National Institute of Child Health and Human Development (2000) report the results of a study of the National Reading Panel, which examined 66 treatment-control groups over 38 studies. Findings showed that teaching phonemic awareness to children significantly improved their reading more than instruction that lacked attention to phonological awareness, leading them to conclude that systematic phonics instruction is beneficial, particularly in the early grades.

One of the notable distinctions in phonics teaching is the distinction between analytic and synthetic phonics. With synthetic phonics, the focus is on teaching children individual letter sounds in isolation. Here, children are taught the connections between letters and sounds and how to blend these together to form words. Analytic phonics, in comparison, focuses on teaching children how to break words down into their constituent phonological units. A study by Johnston, McGeown and Watson (2012) compared the effects of early years synthetic and analytic phonics tuition on the reading and spelling development of 10 year-old children. Their findings revealed that those who had received synthetic phonics tuition in their early years performed better on all measures of reading and spelling than children who had received analytic phonics teaching. In addition, Johnson and Watson (2004) found that 5-year-old beginning readers taught by synthetic phonics methods performed better on measures of reading, spelling, and phonemic awareness than two groups of children taught by analytic phonics, one of which also received phonemic awareness training designed to help children distinguish phonemes in spoken words. They concluded from this that synthetic methods are more effective than analytic methods, supporting a wide body of evidence in favour of synthetic phonics teaching (e.g. see Bowey, 2006; McGeown and Medford, 2013; Wyse and Goswami, 2008; Wyse and Styles, 2007).

However, there is also evidence to support the use of analytic phonic methods. Johnston et al (2012), above, for example, illustrated that analytic phonics tuition still had a positive effect on literacy outcomes, albeit not as strong as that from synthetic phonics tuition. The differences between these two variants of phonic tuition were further investigated by Comaskey, Savage and Abrami (2009), who randomly allocated kindergarten children to receive either a synthetic or an analytic-based method of phonic tuition over 13 weeks. Their results suggested that synthetic and analytic phonics programmes have different effects on phonological development, such that synthetic phonics benefited segmenting and blending skills, whereas analytic phonics benefited rime awareness. In a follow up study, Di Stasio, Savage and Abrami (2012) re-assessed the literacy skills of participants who had received synthetic or analytic training one year after the original experiment. Children who had received training on the analytic phonics programme displayed significantly better reading comprehension than the synthetic phonics group, leading Di Stasio, Savage and Abrami to conclude that analytic phonic programmes may provide modest immediate outcomes but also that such advantages are sustained over time. In addition, Savage, Abrami, Hipps and Deault (2009) compared the effects of two computer-based phonics programmes including a phoneme-based synthetic phonics method and a rime-based analytic phonics method. Findings revealed a significant improvement in letter knowledge in children receiving the analytic phonics training, whilst children who received synthetic phonics training showed significant improvements in phonological awareness and reading comprehension.

Despite the differences between these two types of tuition, it seems that both methods of tuition have (differing) benefits. Indeed, both methods have been used to create reading interventions based on training children's phonological awareness. Table 1.3 outlines the nature of phonological awareness-based interventions to date, and highlights research evidence supporting their usage. It should be noted that the term ‘intervention’ refers to targeted tuition, as opposed to general ‘instruction’ which is a more general term for teaching methods. Some of the interventions listed here, however, are often implemented as part of the general classroom literacy tuition (e.g. Jolly phonics).

Table 1.3: Phonological Awareness-based interventions

Intervention and Authors	**Content**	**Selected Research Findings**
Lindamood Phonetic Sequencing (LIPS) Programme (Lindamood and Lindamood, 1975) **Also known as the Auditory Discrimination in Depth (ADD) programme.**	Teaches individuals the skills that are necessary to be able to successfully decode words and to identify the individual sound components and blends in speech. The programme can be adapted to suit individual needs and is often used with children with reading difficulties. ADD can be used alone or as an accompaniment to other reading programmes.	Alexander, Anderson, Heilman and Voeller (1991) investigated the ability of ADD to remediate deficits in decoding in a group of severely dyslexic children. They trained 10 school pupils aged 7-12 years using ADD, and found evidence of a significant increase in performance on both phonological awareness and analytic decoding tasks. Truch (1994) used ADD to examine whether such training could have a significant effect on reading performance in 281 participants aged 5-55 years. Results showed a significant effect of training in relation to reading, demonstrating a significant increase in decoding, word identification, spelling and reading.

Reading Mastery (Engelmann and Carnine, 1982)	A systematic, explicit phonics curriculum created to teach beginning reading skills to students in kindergarten and first grade. Includes 160 half-hour daily lessons that teach basic phonemic awareness, phonics and comprehension skills.	Marchand-Martell, Slocum and Martell (2004) demonstrated positive outcomes with a wide range of populations who were at risk of developing reading problems. Wang, Spychala, Harris and Oetting (2013) found that kindergarteners who received explicit training demonstrated good use of phonemic awareness and phonics later on, and also found that these skills were maintained in early elementary school.
Reading Recovery© (Clay, 1993)	An intensive one-to-one literacy programme designed for children aged 5-6 who are identified as being at risk of reading failure. Originally developed in New Zealand, Reading Recovery is now widely used throughout the world.	Center, Wheldall, Freeman, Outhred and McNaught (1995) evaluated the effectiveness of Reading Recovery in comparison to a control condition in 10 primary schools. Results showed that at 15 weeks, children receiving the reading recovery programme performed better than the control group on all measures of reading, but that there were no differences between children receiving the RR programme and children in the control group at 30 weeks. Hobsbaum (1997) conducted a longitudinal study into reading recovery. Data illustrated that the Reading Recovery programme was successful in improving literacy attainment, with 70% of students improved to a level sufficient enough to be dismissed from the programme.

	Sylva, Hurry and Peters (1997) describe a large national evaluation in the UK, illustrating that RR increased reading attainment and that gains remained more than one year after the intervention was terminated. Reynolds and Wheldall (2007: 218) concluded that Reading Recovery has provided an excellent model in demonstrating how to plan, promote, and implement an intervention across an educational system and how to design a professional development program. Holliman and Hurry (2013) evaluated the longer-term effectiveness of RR three years after administration. Findings illustrated that children who had received training on RR performed significantly higher on the National Curricullum compared to children who had not received RR, indicating that the effects are still present three years on.

Every Child a Reader© (ECaR)	Every Child a Reader (ECaR) is a literacy strategy for teaching reading and raising attainment at Key Stage 1. ECaR provides a layered approach to literacy tuition, encompassing both a simple view of reading including word recognition and comprehension, and systematic phonics, with Reading Recovery at the centre of the intervention.	Tanner, Brown, Day, Kotecha, Low, Morrell, Turczuk, Brown, Collingwood, Chodry, Greaves, Harrison, Johnson and Purdon (2010) evaluated the ECaR programme, concluding that both Reading Recovery and ECaR generally had positive effects on reading ability, and also had smaller effects on reading related attitudes and behaviours. Both ECaR and Reading Recovery were shown to have the capacity to help children at risk of falling behind their peers in literacy with long term benefits.

Success for All (Madden, Slavin, Karweit, Dolan and Wasik, 1991)	An intervention based on cooperative learning, providing schools with a reading curriculum for pupils aged 5-11 years. Focuses on phonemic awareness, phonics, comprehension and vocabulary development.	Ross and Smith (1994) evaluated first year outcomes of Success for All in 131 students in kindergarten-2nd grade. Reading test results show a significant advantage on word identification and word attack at kindergarten, but no differences for 2nd graders. Slavin, Madden, Dolan, Wasik, Ross, Smith and Dianda (1998) report results from 23 schools administering Success for All. Findings illustrate increased reading performance as a result of exposure to Success for All, and students in every district learned significantly more than matched controls, although significant effects were not seen for every measure at every grade. Borman and Hewes (2002) additionally concluded that students receiving training on Success for All had better achievement outcomes, fewer special educational placements, fewer retentions, and at the same educational expense of controls.

Jolly Phonics© (Lloyd, 1992)	A fun, child-centred approach to teaching literacy through synthetic phonics. A multisensory method incorporating actions for each letter sound, motivating children and teachers. Jolly Phonics teaches children 5 key skills for reading and writing, including learning letter sounds, letter formation, blending, segmenting, and encountering tricky words with irregular spellings.	Stuart (1999) compared the effects of Jolly Phonics teaching to a control group who received training on big storybooks. Findings showed that Jolly Phonics training accelerated children's acquisition of phoneme awareness and phonics knowledge, and their ability to apply these skills to reading and writing. Bowyer-Crane, Snowling, Duff, Fieldsend, Carroll, Miles, Gotz and Hulme (2007) compared Jolly Phonics training to an oral language intervention programme, concluding that Jolly Phonics training benefitted literacy and phonological measures at a level beyond that of oral language training.

Read, Write and Type (Talking Fingers, 1994)	A reading programme aimed at 6-9 year old beginning readers, and is also used with children learning English as a second language and older struggling readers. The programme incorporates a number of activities focussing on phonemic awareness, phonics, fluency, vocabulary and comprehension.	Torgesen, Wagner, Rashotte and Herron (2003) conducted a review of existing research focusing on the outcomes of both the 'ADD' programme, and the 'Read, Write and Type' programme when administered to children at risk of reading difficulties in first grade. Their review illustrated that both ADD and Read, Write and Type were effective ways of providing reading instruction to prevent reading problems in at-risk children. The ADD programme was able to reduce the number of children with poor decoding skills from 6% before the intervention to just 1% following reading instruction using this programme. ADD was also able to reduce the number of children with poor sight word reading from 4.5% to less than 1%, and those with poor comprehension skills were reduced from 6% to 3%.

Sound Linkage (Hatcher, 1994; 2000)	Trains children to identify words as units within sentences, identify and manipulate syllables, blend phonemes, identify and supply rhyming words, identify and discriminate phonemes, succeed in phoneme segmentation, deletion, substitution and transportation, and understand phonological linkage activities. The revised version is a highly structured approach to reading and writing coupled with systematic phonological awareness training. The intervention is suitable for primary school children in years 1-6, where the teacher works with small groups of children twice per week for 35 minutes per session over 12-25 weeks.	Hatcher, Hulme and Ellis (1994) concluded that interventions aiming to boost children's phonological skills need to be integrated with the teaching of reading if they are to be maximally effective in improving literacy skills. Hatcher (2000) reports the effects of Sound Linkage for 427 children aged 6-16 years with reading difficulties. Findings showed that those with dyslexia responded more successfully than a low IQ group, although both groups showed some evidence of effectiveness. Roth and Schneider (2001) tested Hatcher's (1994) phonological linkage hypothesis, confirming the assumption that a combination of phonological awareness and letter-sound training was more successful than phonological awareness or letter sound training alone. Hatcher, Goetz, Snowling, Hulme, Gibbs and Smith (2006) compared the effects of the Early Literacy Support System with Sound Linkage training and found that children in both groups made equivalent and significant gains in both reading and spelling that were maintained at the follow up.

Earobics (Cognitive Concepts, 1997)	Earobics' unique instructional design provides a diverse, differentiated approach to literacy suited to each student's individual needs. Aimed at developing the literacy skills of children from pre-kindergarten through third grade.	Pokorni, Worthington and Jamison (2010) randomly allocated 60 stidents with language deficits to one of three intervention groups, comparing the effects of Earobics, Fast ForWord and LiPS. Students received three 1-hour daily intervention sessions over 20 weeks. Results illustrated that both Earobics and LiPS were associated with gains on phonological awareness measures 6 weeks following the intervention. The Earobics website claims that "97% of students using Earobics have shown improvement" (Earobics, 2007, online)

Fast ForWord (Scientific Learning Corporation, 1998)	A series of computer-based language programmes to improve children's reading and oral language skills. Aims to develop the cognitive skills which enhance learning through training children on 3-5 days per week over 8-12 weeks.	Temple, Deutsch, Poldrack, Miller, Tallal, Merzenich and Gabrieli (2003) found that children with dyslexia experienced changes in their brain activation patterns and significant improvements in reading and language skills following training on the Fast ForWord programme. Friel-Patti, DesBarres and Thibodeau (2001) report findings from five case studies where Fast ForWord had been used with children with language difficulties. Findings showed that 3 out of the 5 chidren experienced modest changes in standardized measures of language following exposure to Fast ForWord. Hook, Macaruso and Jones (2001) investigated the effects of Fast ForWord training on reading and spoken language skills in children who experienced difficulties in phonemic awareness and word identification. Children who received the Fast ForWord training showed improvements in phonemic awareness. They also made gains in speaking and syntax at the immediate post test, but these gains were not maintained over 2 years.

‘Phono-Graphix’ programme (McGuinness and McGuinness, 1998)	Designed to enhance phonological awareness through stages in which each section of teaching built upon the previous. Children are therefore taught to decode multisyllabic words in the same way as monosyllabic words. Taught children phonetic sounds in the context of words, e.g. the ‘a’ in ‘cat’ or the ‘a’ in ‘cake’. The intervention involved 4 tests: segmenting, blending, phoneme manipulation and code knowledge. Implemented though 1:1 instruction with a teacher for 1 hour per week, supplemented with three 20-minute sessions with a TA or parent over a period of 12-26 weeks.	Dias and Juniper (2002) found that reception children taught using the Phono-Graphix programme made more progress in literacy than children receiving other training methods, and did not require additional literacy tuition in the following year. Wright and Mullan (2006) investigated the effects of the Phono-Graphix programme with ten learners aged 9-11 years with specific learning difficulties or dyslexia. Students were instructed on a one-to-one basis, receiving 24.3 hours of instruction each. Findings suggest that training on the Phono-Graphix programme aided phonological processing skills, and resulted in gains in reading age of approximately 21 months. Shaw and Davidson (2009) found that children in Primary 2, who had already received some formal reading tuition using phonics methods, improved in all literacy skills assessed following instruction on the Phono-Graphix programme.

Sound Discovery© (Grant, 2000)	A commercial synthetic phonics programme which builds upon Jolly Phonics, using a method called 'Snappy Lesson©'. During each session, the teacher or TA and children use phoneme cards to build up words and manipulate the sounds within words.	Grant (2004) reports a six year longitudinal study in which Sound Discovery was employed as a method of synthetic phonics teaching. Sound discovery was found to raise literacy attainment for all pupils, and to close the gender gap with respect to literacy.
The Word Wasp (Cowling and Cowling, 2001)	A highly structured spelling programme for pupils with dyslexia, involving three to five 20-minute one-to-one sessions per week with a teacher, TA or parent. A variation, The Word Wasp Hornet, also exists for pupils with significant learning difficulties.	

'ABRACADABRA' (Grover, n.d.)	A computer-based literacy intervention in which computer activities focused on word analysis, text comprehension and reading fluency. Contains a phoneme-based synthetic phonics method and a rime-based analytic phonics method, training children in small groups 4 times per week for 12 weeks.	Savage, Abrami, Hipps and Deault (2009) compared training on phoneme-based synthetic phonics to training on rime-based analytic phonics, finding significant improvements in letter knowledge in the analytic phonics group and significant improvements in phonological awareness, listening comprehension and reading comprehension in the synthetic phonics group. Di Stasio, Savage and Abrami (2012) also found support for analytic methods.
Early Reading Tutor (Gibbs, Campbell, Helf and Cooke, 2006)	110 one-to-one ten minute sessions that supplement Reading Mastery	Wang et al (2013) found that participants demonstrated use of phonemic awareness and phonics when explicitly trained and that these skills were maintained in early elementary school. The McGraw-Hill Information for Educators report also reports studies using Early Reading Tutor as a method of reading intervention. The report concludes that students receiving Early Reading Tutor for supplemental intervention made significant gains in reading.

Wizards of Words (WoW) (Barnardos, 2008)	A one-to-one programme for children identified as being at-risk of reading problems. Aims to improve children's reading comprehension, fluency, vocabulary and phonemic awareness, encourage and promote interest in reading, and improve competence and enjoyment.	Fives, Kearns, Devaney, Canavan, Russell, Lyons, Eaton and O'Brien (2013) targeted WoW at socially disadvantaged children in first and second grade who were experiencing delays in reading but were not eligible for formal literacy support. Findings showed that WoW was effective for enhancing phonemic awareness, word recognition, phonic knowledge and self beliefs, but was not effective for enhancing reading comprehension, vocabulary, reading accuracy or spelling performance. The intervention was more effective for children below the 16th percentile, and also more effective for boys.
Toe by Toe (Cowling and Cowling, 2009)	A highly structured, multisensory teaching programme, teaching basic literacy skills to learners of all ages using a basic phonic-based method. The programme involves daily 1:1 sessions with a teacher, TA or parent, each session lasting 10-20 minutes. The entire programme takes approximately 5-6 months to complete, although it can also be implemented over shorter time frames.	Hutchison (2006) reports the results of a study which administered the Toe-by-Toe programme to students who struggled with reading. Findings showed that students improved in their reading age by an average of 2.5 years following Toe-by-Toe training.

Think about it' (Ferguson, Currie, Paul and Topping, 2011)	Three separate strands of training, including teaching phonemic awareness through formal phonics tuition, developing a systematic cueing system, and us of meta-cognitive strategies to improve decoding and comprehension.	Ferguson, Currie, Paul and Topping (2011) support the use of this intervention, finding that children's attainments in word reading, spelling and reading comprehension were significantly improved as result of the intervention both at the end of the intervention and at the follow-up one and two years later.
Rapid Phonics (Grant, 2012)	A unique catch-up programme designed for use with struggling readers in year 1 and upwards. Based on Sound Discovery, Rapid Phonics teaches phonics in fast-paced sessions with quick and easy assessments	Pearson schools and FE colleges (2014) report findings from a number of case studies, concluding that Rapid reading can treble pupils' normal rate of reading progress.
Read Write Inc (Ruth Miskin Literacy, 2012)	A whole school literacy programme for 4-11 year-olds, designed to create fluent readers, confident speakers and willing writers. Rooted in the primary National Curriculum, Read Write Inc teaches phonics for early reading and writing, literacy and language skills for developing comprehension, writing and spoken language skills and spelling.	Case studies support the use of Read Write Inc in a number of different settings, age groups and ability groups (e.g. see http://www.ruthmiskintraining.com/case-studies/index.html).

Read Write Inc Fresh Start (Ruth Miskin Literacy, 2012)	A specially adapted phonics-based literacy programme for older children who have not learned to read and write the first time round. Teaches the 44 sounds and corresponding letters using picture prompts, and allows children to work at their own level to develop skills necessary to become a skilled reader.	Case studies support the use of Read Write Inc and Fresh Start in a number of different settings, age groups and ability groups (e.g. see http://www.ruthmiskintraining.com/case-studies/index.html).
Project X (Oxford University Press, online, 2013)	A 3D illustrated character adventure to get children reading for pleasure. Addresses key issues across the whole school, including phonics, comprehension, developing talk and writing, and raising achievement. Administered as part of the Oxfordshire Reading Campaign.	Bailey and Clark (2013) report findings of the Oxfordshire Reading Campaign, in which Project X was administered in a large number of schools and was found to be effective in a large number of cases.
Floppy's Phonics Sounds and Letters (Hepplewhite, Hunt and Brychta, 2011)	A systematic and structured step-by-step phonics teaching programme with built in revision. Uses Biff, Chip and Kipper to engage children.	

Phonological Awareness Training Programme (PAT)	Teaches children to read, write and spell phonically regular single syllable words by making analogies.
Wellington Square	A 14 week programme for children aged 6-11 years, widening reading experience as the scheme progresses. Teaches children to extract key information from questions, scan text to find answers, blend sounds to read words, use knowledge of letters and sounds to read simple texts, understand text and recall main events, take account of punctuation and use expression and intonation to enhance meaning.

Beat Dyslexia: Read, Write and Spell	Developed for children who struggle to read, write and spell. Covers all areas of literacy with a multisensory approach, incorporating auditory, visual and kinesthetic learning styles. Aims to improve alphabetic order, letter formation, listening and attention, and develop word building strategies, phonic skills and independent learning.
Syllasearch (Beck and Beck, 2013)	Assists multisyllabic word reading by splitting words into syllables and joining syllables together to form words.
Direct Phonics	A direct method of instruction developed for children who struggle with basic literacy. Can be used alongside Jolly Phonics etc. Teaching Assistants work with small groups for 20 minutes per day, with each book delivered over 1 term.

Action Words	Designed for use with children in reception classes upwards. Teaches sight vocabulary by assigning a meaningful action to each high frequency word. Adult words with individuals, pairs or small groups on 5 new words per week.
Ph. A. M. E.	Focuses on phoneme segmentation and blending. TA words with individual children on a one-to-one basis for 5-10 minutes per day.
Catch Up Literacy	An intervention designed for use with children in years 2-6 who are performing at at least National Curriculum level 1. TA works with individual children for 10-15 minutes once or twice per week over 1-3 terms.
Accelerated Accelewrite	An computer-based intervention using a talking word processor to type sentences following phonic patterns. Designed for children in years 3-6. TA works with individual children for 20 minutes per day for 4 weeks.

Better Reading Partnerships	Primary school intervention for children in years 1-6. An intervention which emphasises parental involvement, where an adult reads 1:1 with the child for 25 minutes at a time, 3 times per week over 10 weeks.

Table 1.3 illustrates evidence for various forms of phonological and phonic training methods, some of which are well-used within education systems worldwide. Many of these interventions follow the three cueing systems model of reading (e.g. *Reading Recovery*) which claims that there are three cues that every reader depends upon in order to successfully decode words during the process of reading. These cues include semantics, syntax, and grapho-phonemic, or letter-sound information. Using this three cueing system, children are firstly encouraged to recognise words based on their context, for example looking at the pictures within a story book, or taking account of other surrounding words on the page which may be easier to recognise. In this way, children are taking account of the semantics of the word. If this semantic level of interpretation fails to provide children with the correct word, they are then encouraged to use the second cue, relating to the syntax of the word. Using this second cue, children are encouraged to identify whether the word is a noun, verb, or adjective, etc, in order to give them a cue to identifying the word based on its syntactical properties. If this continues to fail to provide the correct word, children are thirdly encouraged to sound out the

word using their letter-sound knowledge. This cueing strategy means that intervention programmes tailored to this approach, such as *Reading Recovery,* do not use simple decoding as a stand-alone strategy for learning to read, but rather, incorporate the whole-word approach together with the application of phonological awareness. *Reading Recovery* has been widely reported for its ability to enhance literacy development, not only immediately, but also longitudinally (see Holliman and Hurry, 2013), and has led to the development of other interventions such as the '*Every Child a Reader'* (ECaR) programme, which provides a layered approach to tuition, encompassing both word recognition and reading comprehension, and systematic phonics, with *Reading Recovery* at the centre of the intervention.

In contrast to this approach, the *Auditory Discrimination in Depth* (ADD) programme, also known as the *Lindamood Phonemic Sequencing* (LiPS) programme, focuses on more 'phonic' methods, teaching individuals the skills necessary to be able to successfully decode words and to identify the individual sound components and blends in speech. This approach to tuition has also been evaluated (e.g. see Torgesen, Wagner, Rashotte and Herron, 2003), and has been shown to be an effective method of improving reading attainment.

Despite good general evidence of effectiveness for these interventions however, it must be considered that not all of the children involved in these studies responded to such phonological training in the way we would expect, and therefore did not make improvements in their reading attainment. For example, research by Center, Wheldall, Freeman, Outhred and McNaught (1995) found no significant differences between children who received *Reading Recovery*© training and children who received a control intervention at the delayed post-test, showing no evidence of a long-term effect. In addition, Hobsbaum (1997) concluded that only 70% of students receiving *Reading Recovery* improved to a level sufficient enough to be removed from the programme, again suggesting that not all children benefitted from this approach. Similar findings have been reported more recently by the European Centre for Reading Recovery (2013), who claimed that 84.1% of children receiving Reading Recovery make accelerated progress and can be successfully returned to class with average attainment levels for their age group, but that the remaining 15.9% did not. Similar results have been found for other intervention methods. For example, Torgesen, Wagner, Rashotte and Herron (2003) found that *Auditory Discrimination in Depth* (ADD) training was able to reduce the number of children with poor reading skills from 6% before the intervention, to 1% following the intervention, illustrating that a small proportion of children still fail to gain sufficient phonological knowledge as a result of such training. Torgesen et al (2003) also concluded that those with poor sight word reading and those with poor comprehension skills were also reduced as a result of *ADD* training, but again, were not diminished completely.

Whilst such types of tuition are generally regarded as being effective then, some children still appear to display a deficit in phonological awareness. It is possible that such deficits in phonological awareness could be secondary to another underlying cause. Chiappe, Stringer, Siegel and Stanovich (2002) investigated the proposition that this core phonological deficit related to reading failure could have an underlying cause in temporal processing. They assessed 30 reading disabled adults, 32 normally achieving adults, and 31 normally achieving children on measures of reading, phonological awareness and timing. Reading disabled adults displayed typical impairments in phonological awareness and pseudoword reading relative to their reading age-matched controls, but outperformed them on the timing tasks. Chiappe et al concluded that although findings did not support the existence of a timing deficit, they did support the involvement of naming deficits in reading disability, highlighting a further deficit.

It is also possible that the deficit in phonological awareness could be the result of auditory processing difficulties. In the 1980s, Tallal introduced the idea of adding an auditory component to reading tuition, claiming that deficits in auditory perception had been shown to correlate highly with language comprehension and basic decoding skills (Tallal, 1980a). Additionally, Tallal (1980b) claimed that further high correlations had been demonstrated between the number of errors made on phonic reading tests and the number of errors made on auditory perceptual tasks, further supporting this relationship, although not inferring causality. In 1996, Tallal, Miller, Bedi, Byma, Wang, Nagarajan, Schreiner, Jenkins and Merzenich conducted an investigation into the effects of daily training using a speech processing algorithm together with computer based activities in twenty-nine language-impaired children aged 5-10 years. Participants completed daily listening exercises where speech was translated into a synthetic form, and computer-based games designed to improve temporal processing (i.e. the rate at which one is able to process auditory information). Tallal et al's findings demonstrated significant improvements in speech discrimination and language comprehension abilities, suggesting that training in this way had the potential to improve basic language abilities, confirming the efficacy of her earlier suggestion.

The potential of auditory training was put into practice with the development of the *Fast ForWord* programme (see Table 1.3). However, the efficacy of the auditory components of *Fast ForWord* is controversial in that children are trained on a large number of auditory-based language components during each session. It is therefore difficult to determine whether there are particular key components to the training programme, and to decipher the exact role of the auditory component in improving literacy attainment. The impact of this auditory training was scrutinised by Cohen, Hodson, O'Hare, Boyle, Durrani, McCartney, Mattey, Naftalin and Watson (2005), who conducted a randomised, controlled trial of *Fast ForWord* with 77 six-to-ten-year-olds with severe language impairment. Despite the fact that all participants displayed significant gains in language, the study failed to demonstrate a significant remedial effect of using *Fast ForWord* over other language programmes involving auditory components, suggesting that *Fast ForWord* is not sufficient to confer additional gains for children with more severe forms of language impairment who are already receiving specialist therapy and/or educational support. In addition, Friel-Patti, DesBarres and Thibodeau (2001) found that only 3 out of the 5 children examined in their case studies made modest changes in their reading performance as a result of *Fast ForWord*© training, further emphasising that not all children benefit from such tuition.

It seems, therefore, that not all children with reading difficulties respond to these traditional approaches to intervention, and the reasons for this are not well understood. In support of this claim, a meta-analysis conducted by Ehri, Nunes, Stahl and Willows (2001) collated data from 43 studies into phonics tuition. They found that phonics training was generally effective at an early age but decreased as children went beyond first grade. In addition, kindergarteners seemed to respond in the same way as first graders, implying that intervening at an early age is just as effective as intervening once children have already received some form of reading tuition. Furthermore, they concluded that systematic phonics instruction was an effective way to remediate the effects of reading difficulties which are not further implicated by cognitive malfunctions. However, despite the general effectiveness of these interventions, they did not work for all children, particularly those who also displayed cognitive deficits.

Further evidence for this lack of generalisability among children with learning difficulties comes from Savage, Carless and Erten (2009) who further explored the potential benefits of phonics interventions when administered by experienced teaching assistants. Findings largely supported the use of such phonics tuition, however, teaching assistants were only able to help a total of 2 out of every 3 children at risk of learning difficulties, supporting the notion that not all children benefit from this method of tuition.

Torgesen (2000) claimed that the ultimate goal of reading tuition is to help children to acquire the knowledge and skills necessary for them to be able to comprehend written text at a level consistent with their general language comprehension skills.

Torgesen reviewed studies that had been designed to improve early reading skills in children with learning disabilities. The studies Torgesen has considered here have indeed made a significant contribution in showing that a large proportion of children at risk of reading failure can improve in their reading abilities as a result of being exposed to reading intervention programmes. However, studies show that approximately 2-6% of all children at risk of reading failure who were involved in these studies remained poor readers regardless of reading tuition, again supporting the idea that not all children benefit from such methods of reading tuition. Torgesen explains this finding, claiming that we do not yet understand the conditions that must be in place for all children to become adequate readers through early intervention. Torgesen concludes that whilst we can be certain of the type of teaching method that is most effective for the majority, it is just as important that we understand the adequate amount of instruction and the most effective conditions for these intervention programmes to be administered in, and this will be discussed more in Chapter 2.

From the findings of phonic-based research listed in table 1.3 and discussed above, we can conclude that there are, and always will be cases where phonics-based training will not be the most appropriate and effective way of addressing literacy difficulties for all children, particularly for those who suffer from more profound difficulties such as dyslexia, which incorporates deficits in many areas of literacy and general learning, and not just phonological awareness. This brings us to ask the question, ‘How can we address these deficits if children do not respond to phonics tuition?’

One approach which has recently received a substantial amount of interest is suprasegmental phonology, and this will now be discussed in relation to literacy skills in Chapter 2.

Chapter 2: Theoretical Overview Part 2 – Suprasegmental Phonology and its Relationship to Reading

2.1 Suprasegmental Phonology, Speech Rhythm and Reading

As indicated earlier, whilst segmental phonology refers to knowledge and awareness of the segmental components of speech, there is another type of phonology which has received less attention in the reading literature, but which also appears to make a significant and separate contribution to literacy development: *suprasegmental phonology.* 'Suprasegmental' refers to:

"a vocal effect which extends over more than one sound segment in an utterance, such as pitch, stress or juncture pattern. In its contrast with 'segmental', it can be seen as one of two main classes into which phonological units can be divided" (Crystal, 2008: 466).

The description and definition of the suprasegmental features of language has caused problems for linguistics because the study of these elements has been less-well developed. Fox (2000) claims that this is particularly relevant in relation to reading theories where phonological descriptions have focused solely on the segmental elements (i.e. phonemes) of language. Fox continues, explaining that it is these segmental features which are represented in spelling and which are therefore responsible for distinguishing between one word and another. Fox claims that suprasegmental features, seeming apparently less significant, are therefore easily ignored, and their relative contribution is often underestimated (Fox, 2000: 2). More recently, Mundy and Carroll (2013) have claimed that research now indicates that awareness of the rhythmic patterns of spoken language may be an important and relatively overlooked predictor of reading ability, highlighting that these suprasegmental elements of language remain under-researched in relation to reading to date.

In an attempt to define suprasegmental phonology in the context of spoken language, Kulshreshta, Singh and Sharma (2012) describe it as the specific features that are superimposed on the utterance of speech. Kulshresha et al identified that common suprasegmental features of language include the stress, tone and duration in the syllable or word for a continuous speech sequence, and highlighted that these suprasegmental features are often used in the context of speech to enhance meaning.

We must also consider the term *prosody*, or *speech rhythm*, as it is otherwise known. These terms will be used interchangeably throughout this thesis. The word prosody originates from the Greek *pros*, meaning 'towards', and *ōidē,* meaning 'song', implying that prosody refers to the melodic aspects of speech. Over time, the term has developed to cover "rhythmic patterns, rhyming schemes and verse structure, but in linguistic contexts, it is more frequently used to refer to the rhythmic characteristics of speech such as stress and intonation" (Fox, 2000: 2), thus linking the term to suprasegmental phonology. For example, the nursery rhyme "twinkle twinkle little star" follows a strong-weak-strong-weak stress pattern.

As the above discussion has indicated, while segmental information is represented in written English, the prosodic, or rhythmic, elements of speech are more difficult to identify. In addition, these rhythmic elements are not as fully represented in written English as they are in other languages such as Greek or Spanish, where there are extra letters in the alphabet, or added diacritics, to indicate to the reader where stress should be applied within multisyllabic words. It may therefore be more difficult for the prosodic elements of speech to be unambiguously rendered when reading in English, as there are few specific written cues for changes in lexical stress and intonation, with the exception, in some cases, of a question mark. An understanding of how to incorporate these language components when reading aloud has often been neglected in models of literacy development. Indeed, Wade-Woolley and Wood (2006: 253) highlighted that “although segmental accounts of reading development and reading difficulties have made important contributions to our understanding of the field, they may have taken us as far as they can”. Wade-Woolley and Wood claim that perhaps another level of analysis may be required to provide answers to remaining research questions about reading development and difficulties.

There has been a recent increase in research which has explored the potential contribution of sensitivity to speech rhythm to literacy, and the impact that it may have on reading acquisition and reading processes. Wade-Woolley and Wood (2006) discussed findings from a number of research studies in relation to speech rhythm and reading, acknowledging that there had to date been little empirical evidence which had identified speech rhythm as a possible indicator of individual differences in reading development. They claimed that linguistic rhythm is crucial for many aspects of language processing. For example, we use knowledge of linguistic rhythm to break down and understand language in its spoken form, as stressed syllable usage often helps us to identify word boundaries. This occurs because English is a stress-timed language, characterised by strong and weak syllables. A strong syllable is one containing a full vowel sound, such as the ‘ee’ sound in ‘see’, whereas a weak syllable will have a reduced vowel sound, often referred to as a ‘schwa’. Cutler and Carter (1987) estimated that approximately 85% of words in English begin with a strong syllable, supporting metrical stress as an indicator of word boundaries. Indeed, Cutler (1994) identified that sensitivity to speech rhythm may be a skill that is necessary to spoken word recognition in infancy. This is supported by research into infant sensitivity to prosodic cues in speech. For example, Nazzi and Ramus (2003) presented evidence that being able to segment speech into word sequences was a skill which emerged in infancy, and suggested that this was crucial to their language acquisition. Their findings also illustrated that infants aged 0-5 months displayed sensitivity to speech rhythm, suggesting that the acquisition of speech segmentation skills is rooted in early speech rhythm sensitivity. In addition, Frota, Butler and Vigario (2014) recently reported that the ability to distinguish phonetic variations in speech that are relevant to meaning is essential for language development in infancy. Frota et al investigated the abilities of 5-6 and 8-9 month-old infants to successfully discriminate between statements and questions, finding that both age groups were sensitive to the prosodic (particularly intonational) cues in speech.

Wade-Woolley and Wood also highlighted that rhythm is important in lexical access, as in English (and many other languages) stress is lexically contrastive; for example, if we consider the pronunciation of the word ‘DEsert’ in comparison to the pronunciation of the word ‘desSERT’. Stress placement is also important, in

English at least, in allowing us to disambiguate between nouns and verbs, for example 'REcord' vs 'reCORD', and 'CONvict' vs 'conVICT'. It is evident, therefore, that stress placement can impact word meaning and could therefore potentially influence comprehension. This is supported by evidence of a relationship between speech rhythm sensitivity and reading comprehension (see Cohen, Douaire and Elsabbagh, 2001; Miller and Schwanenflugel, 2008; Schwanenflugel, Hamilton, Kuhn, Wisenbaker and Stahl, 2004; Whalley and Hansen, 2006).

The importance of stress awareness has led to a commonality amongst researchers to measure the single component of stress and assume an overall measure of prosody (e.g. Wood, 2006; Wood and Terrell, 1998). However, recent findings have suggested that speech rhythm is not a unitary construct (see Holliman, Williams, Mundy, Wood, Hart and Waldron, 2013), and that sensitivity to the different rhythmic components of language may be related to reading in different ways. For example, while stress sensitivity has been repeatedly demonstrated to be implicated in successful reading development, intonation sensitivity may also play a role. This was demonstrated by Miller and Schwanenflugel (2008), who measured the oral language features of 92 children in first and again in second grade, additionally administering assessments of reading fluency and comprehension at the end of third grade. Findings revealed that reading with fewer pauses in first grade was positively related to good use of intonation in the second grade, and that this intonation was a significant predictor of later reading fluency. Miller and Schwanenflugel attempted to explain these findings by claiming that prosodic reading may indicate that children are capable of reading fluently, supporting the link between the use of rhythm (particularly intonation) in reading and overall reading performance. Schwanenflugel, Hamilton, Kuhn, Wisenbaker and Stahl (2004) also found evidence of a relationship between use of reading prosody, decoding speed and reading comprehension in a sample of 123 third graders and 24 adult readers. Findings showed that those with fast decoding abilities made shorter and less variable pauses within sentences, and had better use of intonation in reading, further supporting the importance of intonation.

It is possible that speech rhythm sensitivity, either as a unitary construct or not, may play a substantial role in the development and understanding of literacy skills. However as Mundy and Carroll (2013) acknowledged, research relating to this topic remains fairly limited. Whalley and Hansen (2006) also acknowledged limitations in existing literature at the time, highlighting that where the role of phonological awareness in reading had been heavily researched and is widely accepted for its importance, the potential role of speech rhythm sensitivity in reading had only recently been explored. Whalley and Hansen investigated this relationship in a study assessing 81 fourth-graders on speech rhythm sensitivity as measured by the DEEdee task and the compound nouns task, and reading ability as measured by the word identification and word attack subtests of the Woodcock Reading Mastery Test (Woodcock, 1987). Participants were also assessed on their reading comprehension as measured by the Neale Analysis of Reading Ability, and phonological awareness as measured using stimuli based on the phonological oddity task (Bowey, Cain and Ryan, 1992). Findings emphasised that speech rhythm sensitivity was able to predict unique variance in reading accuracy and comprehension, confirming the relationship between speech rhythm sensitivity and reading. However the link between phonological awareness and speech rhythm in reading remained unexplained.

Vihman (1996) claimed that an understanding of the development of prosody and the rhythmic properties of language is not only vital for language development, but is also crucial for phonological development, suggesting that there is a relationship between speech rhythm sensitivity and phonological awareness regardless of reading performance. One of the first studies to demonstrate this link was by Wood and Terrell (1998), who investigated the degree to which awareness of rhythm may impact phonological awareness and subsequent reading performance. They employed a cross-sectional design, assessing whether those defined as poor readers showed a specific insensitivity to the rhythm of speech. Findings showed that those with reading difficulties performed at a lower level than their peers on word recognition tasks and stress sensitivity tasks, thus suggesting that poor readers experience a developmental delay in their rhythmic awareness.

This link between phonology and speech rhythm sensitivity has been consistently demonstrated across many research studies. Wood (2006) for example, conducted a study focusing on the relationship between metrical stress patterns, phonological awareness and early reading development. Wood reports two experiments, one focussing on 4-5 year old beginning readers, and one focussing on 5-7 year olds. Overall results indicated that the older children, as expected, outperformed the younger children, and that performance on the metrical stress task was associated with performance on measures of phonological awareness. In addition, metrical stress sensitivity was able to account for unique variance in spelling ability when controlling for both phonological awareness and vocabulary. These findings not only support the relationship between speech rhythm sensitivity and phonological awareness, but also suggest that speech rhythm sensitivity makes an additional contribution to literacy when accounting for phonological awareness, and also has the potential to affect spelling ability as well as reading performance. However, Wood did not consider the importance of vocabulary knowledge in this relationship, which may be an important factor contributing to children's reading comprehension as well as their sight-word recognition.

Holliman, Wood and Sheehy (2008) therefore included an additional measure of vocabulary in their methodology, supporting previous claims by confirming that the relationship between stress sensitivity, phonology and literacy was under-researched. Holliman et al tested forty-four 5-6 year olds on their phoneme awareness, rhyme awareness, reading ability and vocabulary as well as testing them on the stress manipulation task. Findings supported the link between speech rhythm sensitivity and phonological awareness, showing high correlations between performance on the stress manipulation task and measures of phonemic and rhyme awareness. Findings also showed that stress sensitivity was able to predict a significant amount of unique variance in reading ability after age, vocabulary and phonological awareness had been controlled for, supporting the strength of the relationship between speech rhythm sensitivity and reading performance.

Further to this, David, Wade-Woolley, Kirby and Smithrim (2007) expanded on previous research by including numerous measures of literacy attainment in a longitudinal study lasting 5 years. Fifty-three school children were assessed on measures of phonological awareness, naming speed, general reading ability and rhyme awareness once a year in grades 1 through to 5. Their results showed that rhythm was significantly related to phonological awareness and naming speed, and was also able to account for a significant amount of unique variance in reading ability at all five levels. A further multi-measure approach was also taken by Holliman, Wood and Sheehy (2010a), who assessed one hundred and two 5-7 year olds on various measures of reading ability, vocabulary, short term memory, rhyme detection, phonological awareness, speech rhythm and non-speech rhythm. Holliman et al reported that speech rhythm sensitivity, as measured by the revised mispronunciations task, was strongly correlated with both reading attainment and phonological awareness. In a later follow up study, Holliman, Wood and Sheehy (2010b) aimed to discover whether speech rhythm sensitivity could significantly predict performance in reading over time. They invited the original 102 participants to take further reading assessments one year after the original study. They recruited 69 of the original participants and re-assessed them on their vocabulary, rhyme awareness, phonological awareness, speech rhythm and various aspects of decoding, comprehension and fluency. Findings continued to support the relationship between speech rhythm and reading, showing that speech rhythm sensitivity was able to predict a significant amount of unique variance in reading ability and fluency after controlling for factors such as age, vocabulary and also controlling for phonological awareness. This finding illustrates that speech rhythm sensitivity plays a unique role in reading development, independent of phonological awareness and therefore supporting the claims of Vihman, (1996). In response to previous literature and their own findings, Holliman et al concluded that there had been no reading intervention to date which had aimed to remediate the deficit in sensitivity to speech rhythm as a possible way of enhancing reading attainment. This conclusion will be revisited in the rationale for this thesis.

If speech rhythm sensitivity can predict reading independently of phonological awareness as suggested by these findings, it is possible that segmental and suprasegmental phonology may be two distinct components. However, as mentioned previously, much research has demonstrated that regardless of this, the two skills are significantly related (e.g. Wood, 2006). Referring back to the literature demonstrating a deficit in phonological awareness in struggling readers (see section 1.2), we can assume from the relationship between speech rhythm and phonology that these children would also display a deficit in speech rhythm sensitivity. This has been demonstrated by Wood and Terrell (1998), who investigated whether poor readers showed a specific insensitivity to rhythm, focusing their attention on a sample of thirty poor readers and ninety chronological age-matched controls. All children were assessed on their rapid speech perception, rhythmic sensitivity, phoneme awareness and rhyme awareness. Findings indicated that poor readers do experience a developmental delay in rhythmic awareness, confirming the link between speech rhythm sensitivity and reading difficulties.

Furthermore, Breier, Fletcher, Denton and Gray (2004) examined children defined as ‘at risk’ of reading difficulties in comparison to normally developing readers. Breier et al tested participants on a voice onset rime measure in which they were required to detect changes between randomly occurring items. Findings demonstrated that the ‘at risk’ children attended less to phonological information and more to subtle acoustic differences such as those involved in speech rhythm. Whilst this supports the link between phonological awareness and reading ability, this finding could also appear contradictory to the role of speech rhythm sensitivity in reading, suggesting that children at risk of reading difficulties actually attend to the rhythmic elements of speech. However, it is also possible that these children attend to the acoustic elements of speech because speech rhythm is a more basic concept that is required before children can acquire segmental phonological awareness. This suggests that perhaps children at risk of reading difficulties haven’t yet reached the level of understanding necessary for segmental phonological awareness to develop and they therefore attend to the rhythmic elements because they are easier to detect.

A similar study focussing on children at risk of reading difficulties was conducted by de Bree, Wijnen and Zonneveld (2006), who investigated whether three-year-olds with a familial risk of dyslexia experienced more difficulty than their chronological age-matched controls on a stress placement task. Findings showed that both the ‘at-risk’ group and their normally developing peers performed better when imitating regular stress patterns than when imitating irregular stress patterns. However, the at-risk group consistently performed below the control group, and were also less accurate on a phoneme awareness task, confirming the relationship between phonemic awareness and reading.

This focus on poor readers was taken a step further by Goswami, Thomson, Richardson, Stainthorp, Hughes and Rosen et al (2002), who were concerned not with ‘at risk’ children, but with children formally identified as experiencing dyslexia. Goswami et al investigated whether auditory perception in the rhythm of speech could facilitate the segmentation of words and could subsequently affect phonological awareness and reading performance. They suggested that the acoustic beats in speech, marked by peaks in amplitude, correspond with vowel location, marking the onset-rime boundaries. Goswami et al compared dyslexic children with normally developing controls, finding that children with dyslexia were significantly less sensitive to rise time and rhythm in speech, supporting the link between speech rhythm sensitivity, phonological awareness and reading. This was further supported by Thomson, Fryer, Maltby and Goswami (2006), who focused their research on undergraduate students with dyslexia. They matched participants to controls based on their chronological age and IQ, and assessed all participants on speech rhythm sensitivity, phoneme deletion, rapid automatised naming, digit span and rise-time discrimination. Findings indicated that dyslexic students performed significantly worse than controls on speech rhythm sensitivity and also on tone and intensity discrimination, suggesting that the relationship between rhythmic insensitivity and reading difficulties continues into adulthood. A similar study by Kitzen (2001) looked at the relationship between reading disability and rhythmic insensitivity in thirty adult readers with a history of reading difficulties when compared to their normal reading counterparts. Participants were assessed on two separate speech rhythm sensitivity tasks. In one task, participants were required to discriminate between two phonemically similar phrases differing only in terms of their rhythmic characteristics, whilst in the second task, participants were required to match a ‘DEEdee’ phrase to the correct word or phrase based on its rhythmic properties. Results showed that the controls performed better than the adults with a history of reading difficulties in both tasks, supporting the notion that those with reading difficulties have impaired speech rhythm sensitivity, even in adulthood.

These findings from adult samples emphasise the importance of understanding the nature of the relationship between speech rhythm sensitivity and reading, so that difficulties can be targeted and dealt with in earlier development. It is evident from reviewing the above literature that there are a number of literacy skills which may act as partial mediators of the relationship between speech rhythm sensitivity and reading, and the need to disentangle the various associations between speech rhythm and literacy has been acknowledged by numerous researchers (e.g. Holliman et al, 2010a; Miller and Schwanenflugel, 2006). Wood and Terrell (1998), reported the suggestion that skills which develop in infancy to facilitate speech perception (i.e. awareness of rhythm) may have an impact upon later phonological development and literacy. The nature of this relationship has been predicted by Wood, Wade-Woolley and Holliman (2009), who attempted to create a model by which researchers could understand the effects of speech rhythm sensitivity on reading development via a number of different pathways (see figure 1.1). They proposed four paths from speech rhythm sensitivity through to reading and spelling attainment, predicting that speech rhythm sensitivity was related to reading and spelling in numerous ways.

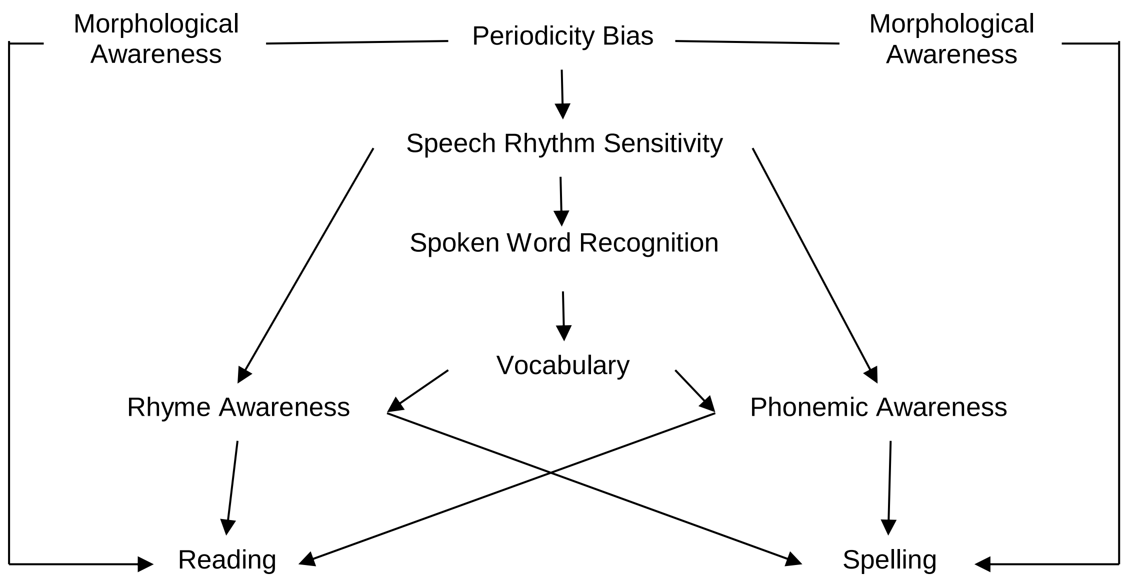

Figure 2.1 Theoretical model proposed by Wood, Wade-Woolley and Holliman (2009), mapping speech rhythm sensitivity to reading and spelling.

Their first path is concerned with the idea that children are born with a periodicity bias enabling them to tune into the rhythmic properties of their ‘mother tongue’ language. This idea was first raised by Cutler and Mehler (1993), who proposed that this bias towards attention to periodicity sounds equips them to exploit linguistic rhythm and enables them to identify word boundaries. Wood et al proposed that this periodicity bias enables children to acquire spoken word recognition, and this is supported by Chait (1983), who identified that the rhythmic features of speech were central to the ability to articulate appropriate representations of words, thus expanding word recognition. Chait focused her study on a single 5-year-old boy who displayed difficulties with segmental phonology but was sensitive to the rhythmic features of speech, concluding that his sensitivity to these features influenced his ability to articulate the correct phonological formation of words. Wood et al proposed that the development of spoken word recognition promotes the development of other literacy skills such as vocabulary knowledge, which in turn promotes the development of phonological awareness. This idea was supported by the Lexical Restructuring Hypothesis (Metsala and Walley, 1998), which suggests that vocabulary growth and segmental restructuring of lexical representations are precursors to phonemic awareness and early reading ability. Walley, Metsala and Garlock (2003) summarised evidence in support of this model, concluding that there is substantial evidence to support the link between vocabulary development and later phonological awareness. This relationship with vocabulary has also been supported by Goetry, Wade-Woolley, Kolinsky and Mousty (2006), who found that speech rhythm sensitivity was associated with vocabulary levels in Dutch children. Further to this, Mann and Foy (2003) investigated the relationship between speech skills, letter knowledge, phonological awareness and early reading skills in 99 preschool children. Findings showed that phoneme manipulation was closely associated with letter sound knowledge, and that rhyme awareness was closely linked with speech perception and vocabulary, supporting the link between vocabulary and rhyme awareness as illustrated in Wood et al's model.

The second pathway in Wood et al's model regarded a more direct relationship between rhyme awareness and speech rhythm through knowledge of onset-rime boundaries and phonemic similarities between words. This pathway is supported by suggestions from Wood and Terrell (1998) and Goswami (2003) who claimed that awareness of the peak of loudness associated with the vowel in a given word or phrase is central to rhythmic sensitivity. Wood et al explained that in being sensitive to vowel occurrences within speech, attention is directed to the onset-rime boundary which allows us to identify phonemic similarities (i.e. rhymes) across words. This relationship to rhyme awareness is supported by Wood (2006), who found that performance on a stress sensitivity task was associated with rhyme awareness even after controlling for age. Wood found that stress sensitivity was also able to predict significant variance in phoneme awareness, thus supporting the link between speech rhythm sensitivity and segmental phonological awareness in both the pathway via rhyme awareness, and a third pathway via phoneme awareness.

Phonemic awareness was therefore proposed as a third possible mediator in the relationship between speech rhythm sensitivity and reading and spelling. Wood et al claimed that children are able to identify phonemes easier in stressed syllables, and that sensitivity to stress placement may therefore be an ability that allows children to gain an insight into the phonemic structure of ambiguous syllables, thus promoting phonemic awareness and subsequently influencing literacy. Over time, the link between speech rhythm and phonemic awareness has been repeatedly and consistently demonstrated in a number of research studies. For example, Goswami et al (2002) reported significant positive correlations between beat detection and phonological processing, even after controlling for age and individual differences in IQ and vocabulary, supporting the relationship between speech rhythm sensitivity and segmental phonological awareness.

However, Wood et al acknowledged existing evidence suggesting that speech rhythm sensitivity may make another contribution to reading that is independent of vocabulary and phonological awareness (e.g. see Holliman, Wood and Sheehy, 2008; 2010a; 2010b). Wood et al proposed a fourth pathway via morphological awareness, which linked this additional variance to the need for lexical stress assignment in reading multisyllabic words. As noted, until recently, popular models of reading development have focused predominantly on how children come to perceive the separable sound segments of spoken language (e.g. Frith, 1985; Ehri, 1997; Ziegler & Goswami, 2005). However, as we move through reading development, segmental phonology becomes less useful for decoding multisyllabic words. Whilst the use of phonological skills is still of importance, other aspects of language such as syntax, morphology, semantics and pragmatics are also important in being able to comprehend written text. Indeed, Shankweiler and Fowler (2004) stated that phonological awareness has been shown to be most strongly related to reading at an early age, with this relationship diminishing over time as morphological awareness and orthographic knowledge become more important. Wade-Woolley and Wood (2006) suggest that as many of the words which children are expected to read are multisyllabic, models of reading development would benefit from incorporating notions of phonological processing that link syllables with words. This is particularly true for English, where stress is not marked orthographically, but where readers are expected to understand where to place the stress, even when reading unfamiliar or novel words. Existing theories do not sufficiently address how children learn to read such multisyllabic words, which require the additional skill of stress assignment. Protopapas, Gerakaki and Alexandri (2006: 428-429) argued the case for stress sensitivity, stating that “if stress assignment is an important and necessary step in reading aloud, then cognitive models of reading must be extended to include it".

In more recent models of literacy development (e.g. Nunes & Bryant, 2009) there has been increased emphasis on morphological awareness, one of the important aspects in being able to decode multisyllabic words. With this in mind, Wood et al proposed a fourth pathway in their model, whereby speech rhythm sensitivity is predictive of reading and spelling, mediated by morphological awareness. Morphology is the study of word structure (Katamba and Stonham, 2006: 19), and morphological awareness is concerned with root words, affixes, and suffixes (e.g. knowledge that the word unacceptable is made up of three morphemes; un (the prefix), accept (the root, which may or may not be words themselves), and able (the suffix)). Morphological awareness is strongly connected to suprasegmental phonology, as when we are decoding multisyllabic words, stress rules become very important and the location of stress can change depending on the suffix of that word. For example, Carlisle (2000) has shown that for words ending in 'ity' or 'tion' there is a stress shift to the syllable immediately before that suffix (e.g. in the word 'electric' the stress is on the 'lec' syllable, but in the word 'electricity' there is a stress shift to the syllable immediately before the suffix, in this case 'tri').

However, although morphology is a key component in reading ability and appears to have strong connections with stress awareness, it is also one which has been scarcely researched in relation to speech rhythm sensitivity. Researchers such as Clin, Wade-Woolley and Heggie (2009) have argued that poor readers may be less sensitive to stress in oral language and less aware of morphological rules when decoding multisyllabic words. In addition, Clin and Wade-Woolley (2007) demonstrated that speech rhythm sensitivity was able to predict 16% of the variance in morphology after accounting for vocabulary, memory and phonological awareness. Furthermore, when morphology was also controlled for, speech rhythm became unable to predict unique variance in reading abilities, further suggesting that morphology could be a key variable.

The four pathways discussed above provide suggestions for the possible mediators of the relationship between speech rhythm sensitivity and literacy development, each of which is supported by an abundance of research evidence. Holliman, Williams, Mundy, Wood, Hart and Waldron (2014) attempted to further disentangle the relationship between speech rhythm sensitivity and reading, acknowledging existing evidence that speech rhythm is not a unitary construct and that the different components of speech rhythm may be related to reading skills in a number of different ways. For example, intonation alone has been found to be related to reading comprehension (see Miller and Schwanenflugel, 2006). Holliman et al devised administered a new measure of speech rhythm sensitivity to 62 children aged 5-7 years, assessing them on measures of stress, intonation and timing at three different levels. Findings illustrated that speech rhythm sensitivity was correlated with vocabulary, phonological awareness and reading performance. They concluded that this was the first step towards developing a more sophisticated understanding of the role of speech rhythm sensitivity in reading development. Further investigation of the model by Wood et al (2009) was conducted by Holliman, Critten, Lawrence, Harrison, Wood and Hughes (2014), who assessed the speech rhythm sensitivity, rhyme awareness, phoneme awareness, morphological awareness, vocabulary, word reading and spelling of seventy five 5-7-year-olds. A path analysis revealed that the pathways proposed by Wood et al, involving links between speech rhythm and both word reading and spelling development via vocabulary, rhyme awareness, phoneme awareness and morphological awareness, were far too simplistic and did not represent a good fit for the data. Instead, Holliman et al proposed a revised model whereby additional pathways are present which link vocabulary to morphology, rhyme awareness to phoneme awareness, and both rhyme and phoneme awareness to morphology. Further path analysis supported the presence of all of these pathways, leading Holliman et al to conclude that the new model was successful in explaining the relationship between speech rhythm sensitivity and literacy in 5-7 year-olds via a complex network of interrelationships. However, the direction of these pathways remains uncertain, and the authors highlight that further research is necessary to test the cause and effect of the relationships between speech rhythm sensitivity, vocabulary, phonological awareness, morphological awareness and literacy, and to determine whether these patterns differ at different points throughout a child's development.

Whilst the different elements of speech rhythm sensitivity may be related to reading and spelling attainment through a number of different pathways, however, there are also a variety of ways in which we can map segmental and suprasegmental phonology to one another, and a number of researchers (e.g. Wade-Woolley and Wood, 2006; Wood, Wade-Woolley and Holliman, 2009) have raised the idea that knowledge of these suprasegmental elements may be a prerequisite to segmental phonological awareness. This suggestion will now be considered further in section 2.2, where a theoretical standpoint for this thesis will be outlined.

2.2 A Theoretical Model Demonstrating the Relationship between Segmental and Suprasegmental Phonology

We are now in a position where we can begin to map out the relationship between segmental phonological awareness and awareness of the suprasegmental elements of language, and determine how these interact in relation to literacy development.

We have already established that a large body of evidence has consistently supported the relationship between reading and segmental phonological awareness. However, as highlighted by Wade-Woolley and Wood (2006), “despite three decades of research in this domain, we have yet to discover the prerequisites for successful development of (segmental) phonological awareness, or to identify the factors responsible for individual differences in reading that cannot be attributed to the individual’s level of phonological awareness” (Wade-Woolley and Wood, 2006: 253). Indeed, Thomson, Fryer, Maltby and Goswami (2006: 334) claimed that the underlying factors leading to characteristic difficulties in representing phonology are still under debate, although they also claimed that a deficit in basic auditory processing is a logical precursor. Furthermore, Chiappe et al (2002) have suggested that the phonological deficit observed in children with reading difficulties may be secondary to another underlying deficit, and thus they concluded that we do not know exactly what causes poor phonological representations.

Literature discussed in section 2.1 supports the link with speech rhythm sensitivity. Wood (2006: 271) proposed that speech rhythm sensitivity may “precede the development of phonological awareness”, and argued that sensitivity to speech rhythm may direct our attention towards phonological features, enhancing phonological awareness and subsequently affecting reading performance. Both Wood and Terrell (1998b) and Chait (1983) also supported the link between speech rhythm sensitivity and phonological awareness, suggesting that sensitivity to speech rhythm may facilitate the development of phonological awareness in relation to both phoneme awareness and rhyme awareness.

In addition, a number of researchers have concluded that speech rhythm sensitivity makes a unique contribution to literacy that is independent of phonological awareness (e.g. Holliman et al, 2010a), suggesting that sensitivity to the suprasegmental elements of language may influence reading at a level that is inaccessible to segmental phonology. Wood et al (2009) attempted to map and explain the possible pathways by which speech rhythm sensitivity could map onto reading and spelling ability, predicting that segmental phonological awareness could be a partial mediator of this relationship.

However, it is also possible that these two ‘parts’ of phonological awareness are two separate entities, complimenting each other in relation to literacy. Indeed, Chait (1983: 292) made a claim that “lexical representations are not strings of phonemes on which stress is marked, but prosodic structures on which segmental features are specified”, arguing that segmental phonological features of language are not independent of the rhythmic features in lexical representations.

It is also possible that segmental phonological deficits may have roots in more fundamental deficits in the processing of speech, specifically in speech rhythm, and this is supported in the research discussed above. Cutler and Melher (1993) proposed that children are born with a bias towards attention to periodicity, and that this equips them to exploit linguistic rhythm. This idea was acknowledged in the model by Wood et al (2009) who identified the periodicity bias as a pre-requisite to speech rhythm sensitivity. It is possible then, that children are born with this periodicity bias, which firstly influences their sensitivity to speech rhythm, and that this, in turn, influences their segmental phonological awareness. Indeed, Goswami (2011) claimed that rhythmic skills are important for the development of phonological awareness, and this is supported by both Thomson, Leong and Goswami (2013) and Bhide, Power and Goswami (2013), discussed further in section 2.3, who both showed that rhythmic training can impact segmental phonological awareness. It is possible; therefore, that awareness of suprasegmental phonology is present before the awareness of segmental phonology, and that speech rhythm sensitivity is therefore required for successful phonological awareness. If this is the case, deficits in phonological awareness can be seen as a symptom, or result of, more fundamental problems with speech rhythm sensitivity, which are previously determined by the child’s periodicity bias. We can consider this in relation to children with reading difficulties, who have consistently been shown to display deficits in phonological awareness despite specific phonological awareness training. A possible reason for this is that these children find phonological awareness more difficult to acquire because of more fundamental difficulties with speech processing, and specifically with speech rhythm sensitivity. If this is the case, we can predict that segmental phonological awareness deficits may occur as a symptom of more fundamental problems with suprasegmental phonology.

We therefore propose a model whereby speech rhythm sensitivity acts as a predictor of both segmental phonological awareness and subsequently reading performance. As literacy teaching stands, children are taught phonological awareness skills in their phonics lessons, which taps into segmental phonological awareness (see figure 2.2). It is proposed that some children do not respond to phonics tuition because their difficulties do not lie within this domain, but rather, difficulties lie within suprasegmental phonology. If we can tap into this by training children's awareness of speech rhythm, we may be able to overcome the difficulties children experience with segmental phonology, and may therefore prevent difficulties in reading.

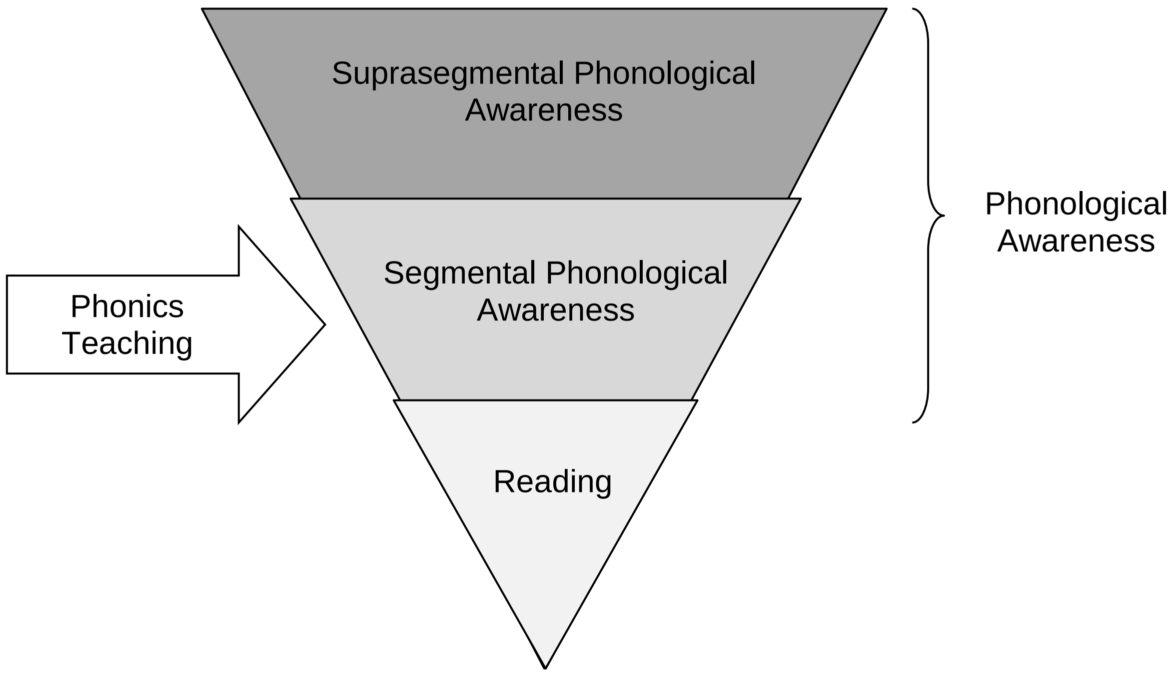

Figure 2.2 A theoretical standpoint depicting suprasegmental phonology as a higher level construct, predicting segmental phonological awareness and reading

As discussed in section 1.3, literacy teaching currently taps into children's segmental phonological awareness as a way of enhancing their reading performance. However, as research has shown, many children experience difficulties with their phonological awareness that do not appear to be remediated by existing phonological awareness-based training methods and this is evident from studies demonstrating that some children remain poor readers despite exposure to such training programmes. It has been considered that deficits in phonological awareness may be secondary to an underlying and more fundamental deficit in speech rhythm sensitivity, and this is an issue that is not currently addressed through literacy teaching methods. We will now consider the development of suprasegmental-, or rhythmic-based interventions, as a possible alternative method for reading tuition.

2.3 Development of Rhythmic-Based Interventions

From reviewing the above literature, it is argued that speech rhythm sensitivity is an ability that children need for the transition from reading monosyllabic words to multisyllabic words. However a question remains over whether this is a skill that could benefit from explicit instruction, and whether training in it could in turn impact literacy attainment. With respect to the first of these questions, Goetry, Wade-Woolley, Kolinsky and Mousty (2006) investigated the stress processing abilities and reading performance of Dutch and French monolingual and bilingual children. They found that Dutch monolingual children had better prosodic processing abilities than French monolingual children as a result of their native stress-timed language. More interestingly however, Goetry et al also reported that for bilingual French-native children schooled in Dutch, stress processing abilities were related to reading skills over 2 years, where as there was no evidence of this relationship between stress processing and reading in Dutch-native children who were schooled in French. This suggests that stress processing is an ability that can be learned in school age children who natively speak a non-stress-timed language. Goetry et al conclude that these results have potential implications for practice, suggesting that the inclusion of activities aimed at developing prosodic and stress sensitivity should benefit children learning a second language, especially when their first language has very different prosodic features.

This suggestion that speech rhythm sensitivity may be learned in school aged children is promising for the development and implementation of interventions aimed at training speech rhythm sensitivity. However, as Holliman et al (2010b) concluded, there had been no intervention to date which had aimed to remediate the deficit in speech rhythm sensitivity in children with reading difficulties as a possible way of enhancing reading performance. Holliman et al summarised this further by stating that a study of this nature would be timely. This brings us on to the discussion of rhythmic based interventions which have recently become recognised within the literature. Although limited in number, studies of this nature offer promising findings.

One of the first prosody-based interventions was conducted in Sweden by Samuelsson (2011). Samuelsson acknowledged that there are very few descriptions of prosody interventions in the literature, which means that clinicians, psychologists and educators must rely on their overall linguistic and therapeutic knowledge when designing interventions for prosodic difficulties. Samuelsson's intervention therefore aimed to address prosodic difficulties in a young boy aged 4 and a half years, training prosodic elements of language throughout six 60-minute sessions. Findings showed that the participant significantly improved on measures of prosodic skills at the word, phrase and discourse level, and also improved in the use of speech prosody, although this was not significant. Although Samuelsson's study bears weaknesses in that it relied on data from a single participant and did not relate these skills to literacy performance, her results support the idea that prosodic skills are something which can be learned, and can be enhanced through specific training activities aimed at improving sensitivity to rhythm.

More recently, Thomson, Leong and Goswami (2013) demonstrated the importance of prosodic sensitivity in developing awareness of the phonological grain sizes required for effective literacy development. Thomson et al. compared a rhythmic-based intervention to a phonetic training programme and an untreated control group, recruiting 33 dyslexic children with a mean age of 9 years, 4 months. They trained children in the rhythmic group on both speech and non-speech rhythm tasks, together with ‘drumming’ exercises and computer-based activities over a 6 week period with each weekly session lasting approximately 30 minutes. Children in the phonetic group received training on a commercially available phoneme-based intervention in equivalent 30 minute weekly sessions over 6 weeks. Results showed that both children receiving the rhythmic-based intervention and children receiving the phonetic-based intervention made equivalent and significant gains in their spelling, word- and non-word reading, phonological awareness and rise-time discrimination, demonstrating the potential of rhythmic training to enhance various literacy skills. However, despite the fact that training showed promising results for the development of literacy skills, the interventions employed in this study only ran for a period of 6 weeks. It is therefore possible that more significant gains may have been observed over a longer period of time. In addition, the study recruited a relatively small sample size, with only 33 children taking part, and this was limited to children with dyslexia. As the authors conclude, research of this nature may benefit from a larger sample size.

In a similar study, Bhide, Power and Goswami (2013) compared the effects of a general rhythmic-based intervention to that of a letter-based phonological intervention in nineteen 6-7-year-old poor readers. The intervention period ran for 2 months and comprised 19 sessions of approximately 25 minutes each. The rhythmic-based intervention trained children's rhythmic awareness through tapping exercises, same-different judgment tasks on tempo and rhythm, rise-time discrimination, clapping to a beat, answering questions on the rhythm of a poem, and a speech rhythm task used as an assessment by Whalley and Hansen (2006). The results showed that rhythmic intervention may benefit reading and phonological awareness, supporting the use of such training. Findings also showed, similarly to Thomson et al, that there was no significant difference between the rhythmic group and the letter-based treated control group on their improvement in reading and phonological awareness, suggesting that both types of tuition have equal impact on reading skills. The authors explain that such findings suggest that training children on rhythmic skills has a positive effect on literacy acquisition and phonological skills. However, despite showing promising results, Bhide et al did not employ an untreated control group for comparison and so we cannot conclude whether the observed improvements were in fact due to the intervention, or whether these benefits were due to the maturation of the participants between the pre- and post-test. It is also not possible to conclude whether such benefits would be observed in all children, or whether benefits would be limited to children with low language skills and cognitive ability such as those who took part in this study. In addition, the sample size was limited to nineteen poor-reading participants who were all of the same age, which raises doubts about the generalisability of the data.

It is evident that this specific field of research remains relatively under-researched, and that existing rhythmic-based interventions remain fairly limited. It is also evident that there are still many unanswered questions relating to the potential of rhythmic-based training methods. However, regardless of the limited nature of these studies, there appears to be a commonality amongst the findings of both Thomson et al and Bhide et al, which suggests that rhythmic training can have benefits for both reading and phonological awareness, at least in those with existing reading difficulties.

If this type of rhythmic tuition can benefit both reading performance *and* phonological awareness as shown by both Thomson et al and Bhide et al, then it is possible that speech rhythm sensitivity is related to phonological awareness in a way that is independent of reading performance, and that this relationship between segmental and suprasegmental phonology is present prior to the onset of reading skills. In addition, with research supporting the link between segmental and suprasegmental phonology (e.g. Wood and Terrell, 1998), and evidence supporting the relationship between speech rhythm sensitivity and reading acquisition (e.g. Goswami, 2002), comprehension (e.g. Whalley and Hansen, 2006), and difficulties (e.g. de Bree et al, 2006), we can conclude that reading theories should acknowledge rhythmic knowledge as a skill required for successful reading.

2.4 Chapter Summary, Rationale and Hypotheses

Studies which have considered the potential contribution of speech rhythm sensitivity to reading development have demonstrated that sensitivity to speech rhythm is linked to segmental phonological awareness (e.g. Wood, 2006; Wood and Terrell, 1998), reading acquisition (e.g. Goswami, 2002; Holliman et al, 2010a, 2010b;

Schwanenflugel et al, 2004; Whalley and Hansen, 2006), reading comprehension (e.g. Whalley and Hansen, 2006), and reading difficulties (e.g. de Bree et al, 2006; Goswami et al, 2002; Kitzen, 2001; Pasquini, Corriveau and Goswami, 2007; Thomson et al, 2006; Wood and Terrell, 1998). These studies have also demonstrated that speech rhythm sensitivity is related to reading independently of its association with phonological awareness (e.g. Holliman et al, 2010a). However, the majority of literacy-based training programmes that are administered in schools focus primarily on developing children's awareness of segmental phonological awareness and disregard the possible contribution of suprasegmental phonology.

Although a great deal of work has examined the potential of phonologically-based training programmes in supporting early literacy skills, evidence has also shown that this type of tuition does not work for all children (Torgesen, 2000). Moreover, such programmes do not address the more challenging aspects of reading that are required for successful transition into secondary school, for example, reading comprehension, and reading multisyllabic words which require the reader to allocate appropriate lexical stress as well as decode at the segmental level. Claims by Protopapas et al (2006) highlight the importance of recognising rhythmic awareness as a necessary skill in multisyllabic word reading, and support the inclusion of such skills in cognitive models of reading development. The model illustrated in section 2.2 proposes that suprasegmental phonological awareness may be a pre-requisite to segmental phonological awareness, and that children require an adequate level of rhythmic awareness before they are able to adequately respond to the phonic-based training which they receive in school. It is essential that the definition of phonological skills relevant to reading is broadened not only theoretically but practically, to enable us to examine methods that could support children's attainment in these important but neglected areas of reading development. To date, however, research focusing on training rhythmic skills as a way of enhancing reading development remains very limited, and those studies which do exist focus primarily on struggling readers within a very narrow age range. It is also important to know the characteristics of children who are likely to benefit from this new approach, so that resources can be targeted more efficiently, and so that a screening tool can be developed to enable this targeted approach to be implemented successfully by teachers.This project therefore aimed to address the following research questions:

1. Can a set of activities which aim to improve children's sensitivity to speech rhythm benefit their reading development?
2. Can these activities result in gains that are at least equivalent to those observed by a more traditional phonological awareness-based intervention programme?
3. When is it most effective to intervene with a speech prosody training programme: early in school, before reading difficulties become established, or once children have started to show some evidence of reading problems?
4. What are the observable characteristics of children who benefit the most from the speech rhythm-based intervention, and do they differ significantly from children who benefit from exposure to traditional phonological awareness-based methods?

In light of previous literature which has demonstrated a significant association between speech rhythm sensitivity and reading development, we expect to observe that a speech rhythm-based intervention will benefit children's reading development more than a control intervention will. However, if the intervention is deemed to be 'effective', it also needs to demonstrate levels of impact that are at least as good as those that can be achieved using more established methods of reading tuition, or at least that it can benefit children who do not respond to other forms of intervention. The extent to which the intervention can match or exceed the outcomes achieved by phonological tuition may be contingent on the age at which the intervention is introduced. It is not yet clear whether it is best to target all children early in their school career to 'innoculate' them against the effects of any speech rhythm difficulties, or to target, more specifically, only those children who have had some exposure to reading tuition and are showing signs of reading difficulties. The inclusion of two different age samples in this project will enable the examination of this issue. Finally, it would be of both practical and theoretical significance to understand the characteristics the children who benefit the most from a speech rhythm-based approach to intervention, and to ask the question of whether these children differ significantly on these characteristics from those children who make significant improvements in their reading outcomes as a consequence of phonological-based tuition.

It is predicted that a speech rhythm-based reading intervention programme will result in:

1. Significantly greater improvement in the early reading skills and phonological awareness of pre-school children (after controlling for individual differences in vocabulary) than that of pre-school children who have been exposed to a control (maths-based) intervention.

2. Improvements in the early reading skills and phonological awareness of pre-school children (after controlling for individual differences in vocabulary) that are equivalent to the improvements made by pre-school children who have been exposed to a more traditional phonological awareness-based intervention.
3. Significantly greater improvement in the word reading and reading comprehension of primary school children (after controlling for individual differences in general intelligence) than that of children who have been exposed to a control (semantic-based) intervention.
4. Improvements in the word reading and reading comprehension of primary school children (after controlling for individual differences in IQ) that are equivalent to the improvements made by children who have been exposed to a traditional phonological awareness-based intervention.

It is further predicted that the children who benefit significantly from exposure to the speech rhythm intervention will differ significantly from the children who benefit from exposure to phonological awareness-based intervention methods on characteristics such as level of speech rhythm sensitivity, phonological awareness, level of reading ability for their age, vocabulary level and IQ.

The next chapter will discuss existing recommendations and outline a set of criteria for creating a successful intervention, with a view to informing the development of the intervention used in the studies detailed in this thesis.

Chapter 3: What Makes a Good Intervention?

Reading is one of the most fundamental life skills we need to survive in the technological society we live in today. Although the majority of pupils can succeed through quality first, class-based teaching (Department for Children, Schools and Families, 2008), many children struggle to grasp the concepts of written language and experience difficulties with many of the processes involved in learning to read. It is in cases where children struggle with existing methods that interventions are often implemented to enable these children to work at a level suited to their individual needs, and to make accelerated progress to reach the level expected of their age group. Intervention is therefore a key component of personalised learning (DCSF, 2008), and has been defined in the American Heritage® Dictionary of the English Language (2011) as the systematic process of assessment and planning employed to remediate or prevent a social, educational, or developmental problem Within education, reading intervention is specifically described as a program which is supplementary to an existing literacy curriculum, and is provided to students with the primary aim of increasing reading levels (Abari, 2014). It has been highlighted that within intervention, a variety of techniques may be used to address the difficulties of individual pupils, with a focus on the main concepts they need to grasp in order to become sufficient readers (Teachnology, 2014). Indeed, Snow, Burns and Griffin (1998) concluded that most reading problems can be prevented by providing effective instruction (i.e. literacy teaching methods) and intervention (i.e. targeted instruction) in preschool and the primary level. But how do we know what will be effective?

Many researchers, writers and educators have made suggestions and recommendations relating to the nature and purpose of educational interventions (e.g. National Reading Panel, 2000; Thomas and Allingham, 2011; National Educational Psychological Service, 2012). However, a lack of standard, generalisable framework and some discrepancies between existing recommendations leads us to ask the question, “What actually makes a good intervention?” - Should we follow guidelines set out by a specific researcher or organisation, or should we focus on a combination of approaches? And what about when certain criteria seem inappropriate for our aims? Perhaps some of these recommendations only apply in specific circumstances or with individuals with specific needs, and perhaps others are more important than initially perceived. Papers such as that by Snowling and Hulme (2011); The National Reading Panel (2000); and Swanson and Hoskyn (1998), have examined evidence from various intervention studies in an attempt to create a more combined approach to intervention guidelines. However, these papers can often be unclear in their goals and suggested criteria, and can therefore be misunderstood as mere suggestions rather than a solid framework on which to base future work.

This chapter therefore aims to review existing recommendations for intervention, and establish a more generalisable framework for creating and using educational interventions. Through this, we aim to:

a. collate and summarise evidence from studies in which suggestions are made for successful or effective intervention,

b. report commonalities amongst researchers’ suggestions and evaluate their significance, and

c. provide a clear and concise framework for creating and implementing an effective literacy intervention.

3.1 Existing Recommendations for Interventions

Table 3.1, illustrates the extent to which intervention studies have already been evaluated, and collates evidence from a number of studies in which researchers have aimed to clarify criteria for successful interventions.

Table 3.1. Summary of Existing Criteria

Author and Date of Publication	Aim and/ or Scope of Study	Key Claims and Contributions to Chapter	Criteria for Inclusion
National Educational Psychological Service (2012)	Reviews methods of instruction and makes suggestions for choosing and implementing effective intervention.	Teachers must ensure a variety of literacy activities. Programmes should be evidence-based. Intervention should be well-targeted. One-to-one or small group tuition is most effective. Intervention should be in short intensive bursts rather than long-term, and should include evaluation through teacher reflection and assessment.	Provides information on selecting and implementing effective intervention. However, claims are very general with a lot of uncertainty.

Snowling and Hulme (2011)	Reviews evidence concerning the nature of reading difficulties, causes of these difficulties, and treatments available.	Intervention should be informed by theory, and should be tested through randomised controlled trials.	Focus is on randomised controlled trials. Summarises a range of research studies over time.
Thomas and Allingham (2011)	Provides a summary and practice guide for intervention programmes	Intervention is most successful when schools use assessment information to identify a target group. There must be a designated time and space for programmes to take place. Timetabling must ensure children do not miss out on a broad curriculum. The impact of the intervention must be monitored. Intervention should be interesting and varied. Children should understand expectations. Programmes should be complimentary to the National Curriculum, and should allow children to make accelerated progress to catch up with their peers.	Provides a useful framework for achieving the best results when integrating intervention into the classroom.

Reid (2010)	Includes criteria on good interventions, how to implement them and ensure success, and illustrates what happens when we don't follow good practice guidelines.	Intervention should accurately target individual needs, should be based on relevant and recent research, should closely monitor progress, should be time limited, delivered by trained adults, be value for money, and be sustainable. Lack of continuity can lead to the 'boomerang effect' - Must be integral to the teaching/learning continuum. Teachers should identify gaps in learning and determine an intervention to best suit a child's needs. There should be clear goals and communication.	Although little evidence is presented in the document, some interesting issues are raised and criteria are linked to implementation in the real world. Highlights the importance of following good practice guidelines. *Note: But which ones should we follow?!*
Singleton (2009)	Summarises research on the impact of specialist teaching on the progress of children and adolescents with dyslexia/ SLD.	Intervention studies must include outcome measures and report standardised scores.	Summarises research that is consistent with relevant scientific evidence, theory and practice.

Slavin, Lake, Davis and Madden (2010)	Reviews achievement outcomes of alternative approaches for struggling readers in primary school.	One-to-one tutoring is effective, but effects only last when classroom interventions continue beyond the initial period. Small group tutorials are effective, but not as effective as one-to-one tuition. Cooperative learning and structured phonetic models have strong effects for low achievers.	Provides evidence of the effectiveness of certain teaching methods in struggling readers.
Institute of Education Sciences (2009)	Offers specific recommendations to help educators identify students in need of intervention.	All students should be screened for potential reading problems. Regularly monitor progress of children at risk of difficulties (Moderate evidence) Provide intensive, systematic instruction on upto 3 foundational reading skills in small groups (Strong evidence). Provide time for differentiated reading instruction, and monitor progress once a month to determine if students still need the intervention (Low evidence).	Provides an indication of the level of evidence supporting each recommendation, illustrating importance and empirical support.

Department for Children, Schools and Families (2008)	Provides a practical guide to intervention, stating what needs to be achieved and how to achieve it.	Intervention must be compatible with mainstream practice and must help pupils apply learning when they return to class to ensure progress is sustained.	Highlights the importance of compatibility with mainstream practice.
Slavin, Cheung, Groff and Lake (2008)	Evaluates reading programmes for students in grades 7-12.	Studies must include control groups with random allocation. Quantitative measures must report standardised scores. Intervention should be at least 12 weeks in duration. Should include at least 15 participants in each treatment group to be conclusive.	Evaluates reading interventions for a wide age range, relating to their effectiveness and respective methodologies.
Denton (2008)	Highlights and explores five over-riding research-supported characteristics of effective instruction for students with reading difficulties	Effective reading teachers must teach skills, strategies and concepts. Must provide differentiated instruction based on assessment results and adapt instruction to meet individual needs. Must provide explicit and systematic instruction, and provide opportunities to apply skills and strategies, and monitor progress regularly.	Highlights 5 key components of effectiveness, based on research by the National Research Council

Scammacca, Vaughn, Roberts, Wanzek and Torgesen (2007)	Summarises 'high-quality' research findings to determine the relative effectiveness of interventions	Studies must address the individual needs of students who experience or are at risk of reading difficulties. Interventions must be provided over a minimum of 100 sessions. Research should include both treatment and comparison groups.	Evaluates school-based interventions from kindergarten - 3rd grade.
Brooks (2007)	Reviews intervention schemes that have been devised to help struggling readers. Intends to inform school's choices.	Schemes should be highly structured. Evaluations should be based on quantitative data from standardised tests. Properly defined control groups should be used through random assignment or matching. Studies must report standardised scores and allow for calculation of effect size. Both pre- and post-test data should be reported.	Explores and evaluates a large number of reading strategies already in use, and provides clear and analytic information on schemes available.
Mackay (2007)	Aimed to eliminate under-performance in literacy in over 6000 students aged 5-17 over 10 years.	Reports should include pre- and post-intervention data, report standardised scores and include between group comparisons.	Longitudinal evidence from a large sample size.

Shanahan (2005)	Outlines the characteristics of literacy programmes for adolescents and provides a guide for schools.	Literacy programmes must aim to increase achievement at a rate faster than the average in order to reach the level of normally-achieving peers. Interventions can be used in a whole class setting, in small groups or one-on-one. Programmes must focus on at least one aspect of literacy.	Focuses on programmes aimed at a range of ages from grades 4-12, and focuses on those who are reading significantly below the level expected for their age.
Chard, Vaughn and Tyler (2002)	Synthesised research on interventions that are designed primarily to build reading fluency for children with learning disabilities.	Fluency programmes should include multiple opportunities to read familiar text. Studies should include established performance criteria.	Highlights the importance of repetition and use of performance criteria.

Department of Human Services (2001)	Provides a summary of a range of interventions, programmes and service models contributing to evidence underlying investment in childhood.	Interventions are viewed as specific purposeful activities that may work either as part of a programme or alone. Should focus on either treatment, prevention or promotion. Interventions can be universal, targeted, or clinical. Studies must display empirical evidence. A programme is efficacious if positive outcomes are determined under highly controlled experimental conditions and must use randomised controlled trials.	Although not solely related to education, the paper provides a strong definition of intervention,
National Reading Panel (2000)	Assessed the status of research-based knowledge and the effectiveness of various teaching methods.	Instruction in guided reading is essential for gains in fluency and comprehension. Research must be experimental or quasi-experimental. Outcome measures must report standardised scores. Papers must test the intervention in students from pre-school to grade 12. A control group or multiple base-line data must be provided.	Screened 100,000 studies for inclusion. Provided a summary of evidence and broad criteria.

Swanson and Hoskyn (1998)	A meta-analysis of experimental research focusing on the efficacy of interventions for literacy difficulties in children and adults	Participants must have an average IQ, but pre-test reading ability should be below the 25th percentile. Intervention studies must involve experimental design and have a control group, and should involve interventions additional to classroom teaching. Must report standardised scores and be able to calculate effect size.	A meta-analysis of all relevant research between 1963-1997 including 180 studies.

3.2 Discussion of Evidence

3.2.1 Nature of Intervention

Interventions are described in the ‘Best Start’ report by the Department of Human Services (2001: 4) as “specific purposeful activities that may have a particular role to play within a programme but can also be viewed as stand-alone activities”. This highlights the importance of compatibility between intervention and other activities within mainstream education, but also highlights the importance of complete programmes of activities which can be used to drive and structure teaching methods for the whole class.

The claims reported by various researchers listed above suggest that there are a number of criteria which are necessary for successful or effective intervention. The overlap between various studies in Table 1 implies that there is a significant impact of applying certain criteria, such as the inclusion of control groups, tailoring activities to suit individual needs, and reporting standardised scores.

The issue of random allocation repeats itself on numerous occasions, being mentioned in reports from Snowling and Hulme (2011), Slavin, Cheung, Groff and Lake (2008), Brooks (2007), and the Department of Human Services (2001). It seems that this is a general unwritten rule of intervention research, although there is some speculation. The Department of Human Services, for example, states that

> *"[participants are] randomly allocated to treatment conditions, rather than being individually matched to a treatment programme, and treatment integrity is tightly maintained to allow comparison of approaches, rather than tailored in content and duration to the individual's needs. Thus, there is the question about ecological validity, or the issue of how and if the same programme outcomes produced under the tightly controlled conditions found in clinical trials will be produced when the intervention is delivered in the community" (2001:12)*

It is indeed questionable whether random allocation should always be the best method to use in an intervention study, as although this allows us to report whether the intervention has been generally effective in a fairly representative sample, it may not reflect the way in which the intervention may be used should it be implemented within the classroom. In many cases, children are specifically allocated to receive an intervention to help them with specific difficulties, and so it is clear that random allocation may lack ecological validity as highlighted by the DHS above.

In addition, when children are removed from the classroom to work on intervention materials, they are therefore missing the work which they would otherwise be doing in class. A key element of these additional interventions then, is that they are compatible with existing classroom approaches, and that they will work alongside the skills that these children will be using to complete activities when they return to mainstream lessons. Without compatibility and integration into the classroom, these children will continue to struggle, and so the circle of under-achievement continues. This is described as the ‘boomerang effect’ by Reid (2010), who identifies that interventions which practice skills unrelated to the tasks in the classroom rely on the pupils to make the connections in learning - yet surely if they could do this, they wouldn’t be under-achieving in the first place.

It is therefore imperative, as claimed by Thomas and Allingham (2011), that interventions are not only integral to the National Curriculum, but that we can also ensure that timetabling of intervention programmes is accurate and carefully planned to enable participating children to partake in a broad curriculum. It is also crucial, as emphasised by the Department for Children, Schools and Families (2008), that intervention must help children apply their learning when they return to mainstream lessons to ensure that any progress is sustained. Without this, it is likely that progress will come to a halt when the intervention is terminated.

“Intervention approaches are therefore most effective when they are fully compatible with mainstream practice” (DCSF, 2008).

It is also important to monitor the impact of intervention in both the participating children alone and in comparison to their normally-achieving peers. This can be achieved through regular monitoring of progress throughout the programme. As highlighted by Shanahan (2005), and Thomas and Allingham (2011), intervention should enable improvement at an accelerated rate to enable children to reach the same level as their peers, and allow them to move out of intervention and back into whole class teaching. Without closely monitoring the progress of these children then, it is possible that they will be receiving training which is inappropriate to their individual needs. The Institute of Education Sciences (2009) suggests that all children should be screened for potential reading problems and that we should regularly monitor the progress of children who are at risk of developing difficulties in mainstream education to determine if they would benefit from additional support. Indeed, Thomas and Allingham claim that

"Intervention is most successful when schools use assessment information to identify the targeted group" (2011: 22)

Identifying a correct target group is imperative for the success of an intervention, allowing materials to be well targeted to suit individual needs and ensure that children gain specialist skills, knowledge and experience in areas which will benefit their education when they return to class. It is therefore important to ensure that the intervention allows both time and resources to provide differentiated instruction based on the needs of the individual (Institute of Education Sciences, 2009). In agreement, Denton has claimed that

"[Powerful instruction must] provide differentiated instruction based on assessment results and adapt instruction to meet individual needs" (2008: 2)

Adaptation for individual needs seems a powerful criteria and one which must not be ignored in the new model. Together with this, we must acknowledge the importance of comparisons between experimental and control groups within intervention work. This is another claim which is repeated in numerous papers (e.g. National Reading Panel, 2000; DHS, 2001; Scammacca et al, 2007; Mackay, 2007; Brooks, 2007; and Slavin et al, 2008). Swanson and Hoskyn specifically stated that

"intervention studies must involve experimental design and have a control group, and should involve interventions additional to classroom teaching"

The use of a control group is beneficial to this type of research given that it allows us to determine the effectiveness of an intervention through comparison with a group of participants who do not receive any training. There are two main types of control: treated and untreated. A treated control in intervention research is a group who receive a different type of intervention as opposed to the one being tested. An untreated control group is one where there is no intervention and participants (generally school pupils in this case) will have no additional support during the intervention period. This allows us to compare the progress of participants in the intervention group to the progress of participants who either were exposed to a different training programme, or received no training at all. Pre- and post-test assessments are essential for the monitoring of progress, and the importance of this is highlighted by Singleton (2009), Mackay (2007), and Brooks (2007).

3.2.2 Delivering Interventions

We have considered the approach which an intervention must take in order to determine that individual needs are met and to ensure that progress continues outside of the intervention, but we must also consider the way in which the intervention should be delivered for best results.

Both Slavin, Lake, Davis and Madden (2010), and Brooks (2007), highlight the importance of a structured programme of activities. Structure is key for impact, particularly in young children who require routine and clear guidance to enhance their learning. However, it is equally important for the administrator to have, and to understand, a structured programme of activities and standardised administration instructions for each task to ensure equality and fair testing. It is important to set clear goals (Reid, 2010), and to know how to achieve them, and communication is vital to ensure that the pupils, their teachers and their parents understand what the problem is, what they are doing to solve it, and what they hope to achieve through doing so. Whilst a clear structure is necessary, however, the National Educational Psychological Service (2102) recognises that teachers must also ensure a variety of literacy activities are presented, and this is re-iterated by Thomas and Allingham (2011) who also claim that intervention should be "interesting and varied" in order to capture and maintain the attention of both the pupils and the staff involved.

"Teachers need to ensure that students are given a healthy, balanced dies of literacy activities" (NEPS, 2012: 6)

The frequency and duration through which an intervention is administered may also have an impact on the success of an intervention. Indeed, Torgesen (2000) claimed that whilst we can be certain of the type of tuition that is most effective, it is just as important that we understand the adequate amount of instruction and the most effective conditions for these intervention programmes to be administered in.

Various suggestions exist regarding the appropriate length of interventions. The National Educational Psychological Service (2012) suggests from meta-analysis that short bursts of intervention are more effective than longer-term training, whilst Brooks (2007) warns that interventions lasting longer than one term should be carefully monitored to assess progress, again suggesting that short, intensive training is the best approach to take.

"Short, intensive bursts of intervention, with daily, targeted support, appear to be more effective than longer term intervention. Therefore, teachers may need to think of their work in half-term or 6 to 12 week blocks" (NEPS, 2012: 14)

3.2.3 The Importance of Evidence

Finally, it is crucial that before any intervention is employed by an institution or individual, we must examine its potential by looking at existing evidence for its effectiveness. Evidence-based practice is essential to achieve and maintain success rates, and research is therefore important to demonstrate an intervention's potential. The DHS (2001) claimed that any study which implies that an intervention is effective must display empirical evidence from experimental research. Reid similarly claimed that interventions should not only be based on research, but that this research must be both relevant to the topic area and must be recent, highlighting a need to focus on current issues within education.

"Interventions should be based on relevant and recent research evidence" (Reid, 2010)

3.3 A Combined Approach to Tackling Underachievement Through Intervention

It is clear from the research presented in sections 1 and 2, above, that there are a number of issues that need to be raised in connection with intervention research, and issues that particularly need to be considered when creating new interventions for use within the education system.

A few questions we might ask include:

1. Who will the intervention target? - Will it be implemented through whole class teaching, or is it specific to children who are struggling with existing methods used within the classroom?
2. Are the intervention materials adaptable for use with children of all ability levels?
3. How will children be screened or targeted for the intervention?
4. Is it appropriate and ethical to randomly allocate children to intervention groups? - Will these children miss out on the potential benefits of intervention all together, or will they receive a delayed intervention at a later date?
5. Is the intervention compatible with mainstream practice?
6. How will the intervention be linked to classroom activities?

7. How will progress be monitored?
8. Will research include a control group? If so, is it fair to use an untreated control?
9. How will the intervention be structured?

With consideration to these questions and to the issues raised in the research discussed above, 12 key criteria have been identified to aid the creation and use of interventions within education.

Intervention Programmes must:

1. **What?** Screen all children on a simple, standardised assessment.

   Why? To identify those who may be at risk of difficulties and who may need to be targeted by the intervention.

   How? Administer a simple standardised (reading) assessment to determine those who are performing at a level below that expected for a child in their age group.

2. **What?** Closely monitor the progress of children at risk of developing difficulties who are not yet in the intervention group.

   Why? So that we can identify if they fall below average and input them to the intervention

   How? Administer regular (reading) assessments to keep track of reading ages.

3. **What?** Select a target group based on the outcome of standardised assessment(s).

   Why? To ensure that the intervention is targeted at the correct group.

How? Calculate reading ages and select those who fall below their chronological age by an appropriate margin.

4. **What?** Randomly allocate targeted children to intervention groups.

Why? To ensure equality between groups for fair comparisons. Relevant children should have already been selected as a target group, so ecological validity is somewhat maintained.

How? Use a random number generator to allocate each participant to a treatment group. Consider the use of treatment controls, and/or a delayed treatment control.

5. **What?** Ensure that all activities completed within the intervention are integral to the national curriculum and are compatible with classroom activities.

Why? To enable children to transfer their knowledge to classroom activities for maximum benefit and to ensure that progress is maintained once the intervention is terminated.

How? Spend time in the classroom to ensure that there are links between intervention activities and lesson content or teaching methods used in class.

6. **What?** Create a tightly structured timetable of varied activities.

Why? To ensure clarity and understanding as well as interest.

How? Include a variety of activities focusing on a few main skills necessary for improvement. Create clear, standardised instructions for each activity and a clear timetable of events.

7. **What?** Set goals for each pupil at the start of the intervention.

Why? To give the pupils something to work towards and a sense of achievement when they reach their goal.

How? Examine children's progress to date and if feasible, set a target to reach the level of their normally-achieving peers by the end of the intervention period.

8. **What?** Monitor Progress throughout the intervention

Why? To ensure that pupils are improving throughout the intervention with a view to meeting their targets. To ensure they are understanding the aims and content of the intervention and applying it in class.

How? Create score sheets for each intervention week, or conduct a 'half-way' mini-assessment.

9. **What?** Ensure that the intervention is adaptable for individual needs.

Why? To ensure that the intervention is suitable for children of a variety of ability groups.

How? Simplify instructions, simplify initial tasks to suit understanding and attention span, slowly build up to a higher level, and continue to monitor response throughout.

10. **What?** Aim for the intervention to last no more than 1 school term.

Why? Evidence has shown that short bursts of intervention are more effective.

How? Create a timetable of activities to fit into a school term of approximately 10-12 weeks, ensuring that these tasks relate to classroom activities so that progress will continue when the intervention is terminated.

11. **What?** Monitor the impact of the intervention in comparison to the control group(s).
Why? To determine the effectiveness of the intervention in comparison to other types of tuition.
How? Administer pre- and post-test assessments of various (literacy) skills and determine the change in performance between pre- and post-test.

12. **What?** Report Standardised Scores.
Why? To enable comparison with other people's scores on the same measures.
How? Used standardised measures to assess progress.

3.4 Summary and Contributions to Thesis

This chapter has provided a summary of evidence from intervention studies and has provided a conclusive evaluation of existing recommendations for creating and implementing effective interventions. From collaborating evidence from a range of reports and research studies, it has been possible to create a more complete framework for intervention together with suggestions on how each criteria can be achieved and applied to research. This will aid the development of a new speech rhythm-based reading intervention for use in the research studies involved in this thesis, and will allow a clear evaluation of the new intervention in relation to these criteria in a later section of this thesis.

Chapter 4: Methodology

The theoretical overview presented in Chapters 1 and 2 has provided evidence in support of the link between speech rhythm sensitivity and the development of reading skills, supporting the development of a new type of reading intervention which will use speech rhythm as a basis for training. In addition, Chapter 3 outlined criteria for successful interventions, which has informed the design and development of a new intervention for use within the research studies involved in this thesis. This chapter presents details of the general methodology for this project, evaluating possible methodologies that could be used in assessing and training the children on their speech rhythm sensitivity. The aim of this chapter is to identify the most efficient and effective way of training children on the different components of speech rhythm with the view to eliminating any deficit in speech rhythm sensitivity as a possible way of enhancing reading attainment. The chapter will then describe details of the new speech rhythm-based intervention, outlining its development and instructions for use. It will also consider various phonological-based and control interventions for the comparison groups in both studies, and review our test battery in preparation for data collection.

4.1 Review of Existing Speech Rhythm Measures

As highlighted in Chapter 2, speech rhythm sensitivity has been shown to predict not just segmental phonological awareness but also various aspects of reading such as reading acquisition (e.g. see Goswami et al., 2002; Holliman et al., 2010a, 2010b, Schwanenflugel et al., 2004; Whalley & Hansen, 2006), reading comprehension (e.g. see Whalley & Hansen, 2006), and also reading difficulties (e.g. see Breier et al., 2004; de Bree et al., 2006; Goswami et al., 2002; Kitzen, 2001; Thomson et al. 2006; Wood & Terrell, 1998). An individual's level of speech rhythm sensitivity has also been shown to distinguish between poor readers and their chronological age matched controls (e.g. see Breier et al., 2004; de Bree et al., 2006) which emphasises its relationship with overall reading performance.

This relationship between speech rhythm sensitivity and reading skills has been demonstrated in a range of different age groups and using a number of different methods. The majority of these have measured speech rhythm using assessment tools that have only recently been developed, particularly over the last decade or so when speech rhythm research has become more prevalent.

Speech rhythm has been defined in Chapter 2 as “a vocal effect which extends over more than one sound segment in an utterance, such as pitch, stress or juncture pattern” (Crystal, 2008: 466). Others, such as Kuhn and Stahl (2003) have further highlighted the importance of pitch, loudness and duration in speech, further bringing to light the components of intonation and timing. This is supported by Schwanenflugel et al (2004) and Miller and Schwanenflugel (2008) who also recognise the role of intonation in their research into speech rhythm.
It emerges then, that there are three key components of speech rhythm, or speech prosody. The first, stress (the varying loudness between syllables and words), changes word meaning, for example ‘CONvict’ vs ‘conVICT’, and signals word boundaries such as in compound nouns like “BREADstick and HONey” in

contrast to “BREAD, STICK and HONey”. Secondly, Intonation (the rise and fall of pitch in speech) can change the meaning of an utterance as a whole, for example “anything else” vs “anything else?” (rising tone), indicating either a statement or a question. It was established in Chapter 2 that where other languages have separate diacritics within their written form to account for changes in intonation, it is difficult to distinguish between tone in written English, and so sensitivity to intonation is a skill that is more salient and could therefore be more difficult to acquire within the English language. Thirdly, timing (the relative duration of syllables and vowel length in speech) also conveys intended meaning to the reader which can be dependent on pauses in speech, for example, “paintbrush” vs “paint (pause) brush” indicating one word or two. Most assessments of speech rhythm, however, have typically focused on measuring a single component, and the majority of literacy studies have looked at either lexical or metrical stress patterns (e.g. see Wood, 2006; Wood and Terrell, 1998).

Over time, it has become increasingly important to identify the methods that are most effective in assessing speech rhythm sensitivity. As proposed in Chapter 2, it is possible that speech rhythm sensitivity may be a precursor to acquiring segmental phonological awareness, yet traditional approaches to reading tuition have focused solely on developing children’s segmental phonological awareness. If suprasegmental phonological awareness is required for successful development of segmental phonological awareness, then implementing an intervention which taps into speech rhythm sensitivity may have a knock-on effect on phonological awareness and subsequently influence reading performance.

The first step towards an intervention targeting speech rhythm is therefore to review previous methods of assessing speech rhythm sensitivity in order to gain an understanding of the most effective way to target speech rhythm sensitivity in a given age group and implement this as an intervention. Several previous studies into speech rhythm and reading will now be reviewed, paying special attention to the methodology used in each study. The aim is to identify the most appropriate methodology for children aged 4-5 (early readers), and struggling readers aged 7-8 years, which can then be used as the basis for creating intervention materials.

Table 4.1 outlines some of the key studies investigating the relationship between speech rhythm and reading in various age groups, with brief descriptions of the speech rhythm sensitivity tasks they employed. Details of their respective methodologies are highlighted with brief notes on sample and findings.

Table 4.1 A summary of existing speech rhythm measures

Author (s) and date	Measure used	Receptive/ productive	Speech/ non-speech	Aspect(s) of SR	Procedure	Sample(s)
Wood and Terrell (1998b)	Rhythmic matching task	Receptive	Speech	Stress and intonation	Participants matched spoken phrases (played on a computer) to low pass filtered sentences where only the stress and intonation remained.	Poor readers compared with reading age and chronological age matched controls. 90 children in total with a mean age of 8 years 2 months.
Goswami, Thomson, Richardson, Stainthorp, Hughes and Rosen et al (2002)	Beat detection task	Receptive	Speech	Stress, rise-time and rhythm	Participants heard sounds sequence through headphones and matched a rhythm to either ‘winnie the pooh’ or ‘tigger and eeyore’ based on rise time and rhythm	101 children in total. 24 dyslexics, 24 age-matched controls (mean age 9 years) and 25 reading age-matched controls (mean age 7 years 11months)

Table 4.1 A summary of existing speech rhythm measures

Author (s) and date	**Measure used**	**Receptive/ productive**	**Speech/ non-speech**	**Aspect(s) of SR**	**Procedure**	**Sample(s)**
Schwanenflugel, Kuhn, Wisenbaker and Stahl (2004)	Reading prosody as a partial mediator	Productive	Speech	Stress, intonation and timing	Children were recorded reading a passage, which was then scored for reading prosody, including pitch and timing.	123 children (mean age 8 years 6 months) and 24 adult readers.
Wood (2006)	The mispronunc-iations task	Receptive	Speech	Stress	Participants heard the names of household items where the stress had been manipulated/ reversed, and had to identify items from a line drawing of a house.	39 children in total, 23 pre-schoolers (mean age 4 years 3 months) and 16 reception children (mean age 5 years 2 months).

Table 4.1 A summary of existing speech rhythm measures

Author (s) and date	**Measure used**	**Receptive/ productive**	**Speech/ non-speech**	**Aspect(s) of SR**	**Procedure**	**Sample(s)**
Whalley and Hansen (2006)	The DEEdee task	Receptive	Speech	Stress	Participants heard words played via a speaker and had to match spoken phrases to DEEdee phrases and discriminate between rhythm, stress, intonation and .	81 children (mean age 9.3 years)
Whalley and Hansen (2006)	The compound nouns task	Receptive	Speech	Stress, pausing and intonation	Participants are presented with a noun phrase that could either represent two or three items depending on stress, intonation and pausing, and are required to choose the picture which best	81 children (mean age 9.3 yaers)

Table 4.1 A summary of existing speech rhythm measures

Author (s) and date	Measure used	Receptive/ productive	Speech/ non-speech	Aspect(s) of SR	Procedure	Sample(s)
De Bree, Wijnen and Zonneveld (2006)	The word stress task	Productive	Speech	Stress	Participants heard stimuli through a speaker and had to repeat non-words that contained stress patterns which varied in regularity.	49 Dutch children at risk of dyslexia (mean age 3.3 years) and 28 Dutch control children (mean age 3.1 years).

We must consider that there are three main components to speech rhythm as shown through various research studies to date, namely, stress, intonation and timing, and all of these elements are crucial to one's overall level of speech rhythm sensitivity. However, many of the tasks outlined in Table 3.1 focus primarily on stress. For example, we can consider the word stress task employed by De Bree, Wijnen and Zonneveld (2006). This task focused on lexical stress as the main component of speech rhythm, in which children were asked to imitate regular and irregular stress patterns. Findings showed that both the control children and children at risk of reading difficulties performed better on the imitation of regular stress patterns than irregular stress patterns, suggesting that children do understand the correct rhythmic patterns of language and can imitate these at a better rate than those which are irregularly stressed. Furthermore, this task was administered to children aged 3 years (pre-readers) which suggests that even pre-readers have some sensitivity to the correct rhythmic patterns of language.

A more common speech rhythm task has been The Mispronunciations Task, used by Wood (2006), Holliman et al (2008), and revised by Holliman et al (2010a). The Mispronunciations Task is a receptive activity in which children, generally aged between 5-7 years, are required to identify items from a line drawing of a house when the spoken stress of those items is either reversed or incorrect in some way. As with many other tasks, the Mispronunciations Task focuses solely on the stress component. However, it has presented some promising results. Wood (2006) found that sensitivity to lexical stress, as measure by the mispronunciations task, could not only account for variance in reading development, but could also account for spelling performance. Furthermore, Holliman et al (2008) showed that performance on this task could predict a significant amount of unique variance in reading when controlling for all other variables. Overall, this task has consistently demonstrated a strong relationship between speech rhythm sensitivity and literacy development. However, whilst stress has been the most widely documented element of speech rhythm relating to reading performance, the role of intonation and timing must not be overlooked, and the mispronunciations task can therefore be criticised for focusing solely on stress awareness.

Another well used and well documented task is The Compound Nouns task, which focuses on measuring word and phrase level stress and timing and thus expanding on other measure which have only measured the stress component. Whalley and Hansen (2006) implemented The Compound Nouns task in their research, along with the well known ‘DEEdee’ task. Findings showed that participants’ performance on the compound noun task was able to predict unique variance in word identification accuracy, whilst performance on the ‘DEEdee’ task could predict unique variance in reading comprehension. The DEEdee Task itself is a measure of phrase level speech rhythm sensitivity, utilising a reiterative syllable substitution technique in which each syllable in a given word or phrase is replaced by the reiterative syllable “dee”, in order to eliminate all original phonemic information but to retain the same prosodic structure and keeping the same stress, rhythm and intonation as the original phrase. In studies using this task (e.g. Whalley and Hansen, 2006; Holliman, Wood and Sheehy, 2012; Mundy and Carroll, 2012), participants match a spoken ‘DEEdee’ stimulus to one of several response options which all share an equal number of syllables but which each vary in terms of the location of stressed and unstressed syllables. The reiterative syllable substitution technique means that rhythmic information, including the stress, intonation and timing of words and phrases, is all retained, meaning that the task acknowledges multiple elements of speech rhythm.

More recent measures have begun to acknowledge these additional elements of intonation and timing. For example, in a study by Holliman et al (2013) all three components of speech rhythm sensitivity were compiled in an assessment paradigm named 'Dina the Diver'. This task enabled investigators to test children's sensitivity to each of stress, intonation and timing separately and on three different levels: word level, phrase level and sentence level. Holliman et al (2013) found that this new measure was able to assess individual differences in speech rhythm sensitivity. In addition, overall scores on this measure were found to correlate significantly with vocabulary, phonological awareness, phonological decoding, text reading accuracy and reading comprehension. Furthermore, not only did this task involve measures of each individual component of speech rhythm sensitivity, it also incorporated measures of word level, phrase level, and sentence level rhythmic sensitivity.

Furthermore, in addition to the speech rhythm studies discussed above, there has also been research into non-speech rhythm such as that by Moreno, Friesen and Bialystok (2011) who used the music curriculum to measure participants awareness of rhythm, pitch and melody and showing a causal relationship between music training and language improvements. It is important to further consider that sensitivity to rhythm can also be measured using non-speech elements and this is highlighted in this research by Moreno, and also as in the musical aptitude test (Overy, Nicolson, Fawcett and Clarke, 2003) as implemented by Holliman et al (2010).

4.1.1 Summary

To summarise, there have been many different methods of measuring speech rhythm sensitivity in different age groups. Many have focused predominantly on sensitivity to stress, although some studies have also included measures of intonation and timing. Some of the measures in Table 3.1 and discussed above are unsuitable for the study of reading in very young children as they involve activities which are too complex or are memory intensive. However, there are a number of elements which can be taken from these assessment tasks and can be adapted and compiled to create a set of training materials more suitable for the younger age range of the pre-readers which will be involved in Study 1, and older struggling readers in Study 2. In the literature, there has been little research conducted with such a young age range, and intervening at the pre-reading stage is therefore relatively under-researched. There are few studies which have used assessment tools with children this young, and so it can be difficult to determine an age-appropriate set of materials. Wood (2006) and Holliman et al (2008, 2010) are some of the few researchers who have studied beginning readers and this links us back to The Mispronunciations Task.

A further methodological issue regards the administration of the test items. Many assessments are administered on a one to one basis with the examiner, a process which is important when working with young children as they require a high level of supervision and guidance throughout the assessment process. This is obviously very time consuming but is the most frequent and most effective method of skill assessment. However when we look at methods of reading intervention we can see that traditional methods of reading tuition use a combination of one-to-one tuition and group activities, and this should be considered when creating new interventions. We must also consider the criteria set out in Chapter 2, to ensure that intervention materials are suitable for use within the classroom.

As a result of reviewing various methodological options and issues with existing methodologies, a set of speech rhythm-based intervention materials were developed which aimed to train children on three key elements of speech rhythm in an attempt to eliminate any deficit in speech rhythm sensitivity as a possible way of enhancing reading performance. In breaking speech rhythm down into its individual components, we have attempted to overcome the limitation of existing literature regarding the dominance of stress. Where this has been the focus of many research papers, and has been centre to measures of speech rhythm sensitivity, other papers have begun to acknowledge that there are other components involved in speech rhythm that may also play an important role in the relationship between speech rhythm and literacy. The intervention therefore comprised three weekly activities: one for stress, one for intonation and one for timing. Each task comprised 5 items per week, plus a pre- and post-test assessment of speech rhythm sensitivity using similar items. These training materials aimed to overcome some of the limitations of existing speech rhythm assessments by including all three elements of speech rhythm, and also aimed to bridge the gap between the speech rhythm and reading relationship and existing phonics-based reading interventions.

4.2 Development of the Speech Rhythm-Based Reading Intervention

The new speech rhythm-based reading intervention was created using ideas from a number of different assessments already in the literature, developing and adapting these ideas to conform to the format of an intervention or training programme rather than a simple assessment of skills. According to Johnston (2006) any model of intervention aimed at children should fit the interests and personality of the child, focus on crucial aspects of speech and language and be suited to the child's communication needs.

The newly-developed speech rhythm-based intervention was designed to be administered over a 10 week period, during which children receive training on three activities per week. These tasks were completed in small groups of three, together with the administrator in weekly sessions lasts approximately 15 minutes (total time of group training sessions = 150 minutes), in addition to carpet time activities in Study 1, each lasting approximately 15 minutes (adding 150 minutes to the intervention in Study 1, with a total intervention time of 300 minutes). Intervention materials comprise of three separate word and picture games which teach children about the three components of speech rhythm: stress, intonation and timing. All tasks comprised pictures and corresponding pre-recorded audio stimuli, and children used response cards to give their answer to each of the items, so that the intervention would be suitable for use within small groups. Because of the two different experiments planned in this project, it was important to create a series of materials that would be suitable for use with very young children (4-5 year olds) at the pre-reader stage, but that could also be adapted for use with older struggling readers (7-8 year olds) who had already received some formal reading tuition.

Initially, a total of 105 words were selected. Seventy words were selected from the children's printed word database (www.essex.ac.uk/psychology/cpwd/); thirty five words for the stress task, and thirty five words for the intonation task. An additional thirty-five compound nouns (adapted from the Compound Nouns Task as mentioned in Table 4.1) were selected for the timing activity, and the frequency per million for each of these items was also determined from the printed word database mentioned above. Pictures which corresponded to these words were then sought through Google images, by searching for pictures that had no copyright attached. There were three tasks in total: stress, intonation, and timing, with five items administered in each task each week during the course of the intervention, giving a total of 15 items per week. It should be noted that the items used in the intervention were different from items used in the assessment of speech rhythm (i.e. the pre- and post-test assessments used untrained items). Correct responses given by each child during the training phase were noted, and the children received feedback on their answers, encouraging them to interact with the trainer and repeat what they had heard.

4.2.1 The Stress Task

For the stress task, children were presented with picture cards and corresponding audio stimuli presented through a laptop with external speakers. All of the audio stimuli were represented by a British English-speaking female voice and were all pre-recorded. Some of these pre-recorded verbal stimuli were presented with the correct stress pattern, whilst others were incorrectly stressed. Both a correctly stressed and incorrectly stressed recording were made for each word, giving a total of 70 different items; 5 for each of the 10 weeks of training plus 5 items in each of the pre-, post- and delayed post-test assessments. Examples of the final materials for the stress task are shown in Figure 4.1, and a full list of item and weekly schedule is included in Appendix 1.

On seeing the picture for each item, children were firstly asked what the item was, “can you tell me what this is a picture of?” in order to ensure that they recognised the item and understood what the picture was. Secondly, children heard the corresponding verbal stimuli to the picture, and were asked whether the spoken word was stressed correctly, “does Janet say this the same as us?”, or incorrectly, “or does she say it a little bit differently?”. Participants responded using two response cards, one with a happy face and one with a sad face. If the stress placement was correct in the audio stimuli then they would show the happy face, and if the stress pattern was incorrect they would show the sad face. Participants received one point for each correct answer given.

Please see Table 4.2 for a complete list of the target words for the stress task together with their frequency per million. Please note that these words are listed in alphabetical order and not in the order they were administered. A full list of items by week is included in Appendix 1, and standardised instructions are available in Appendix 2.

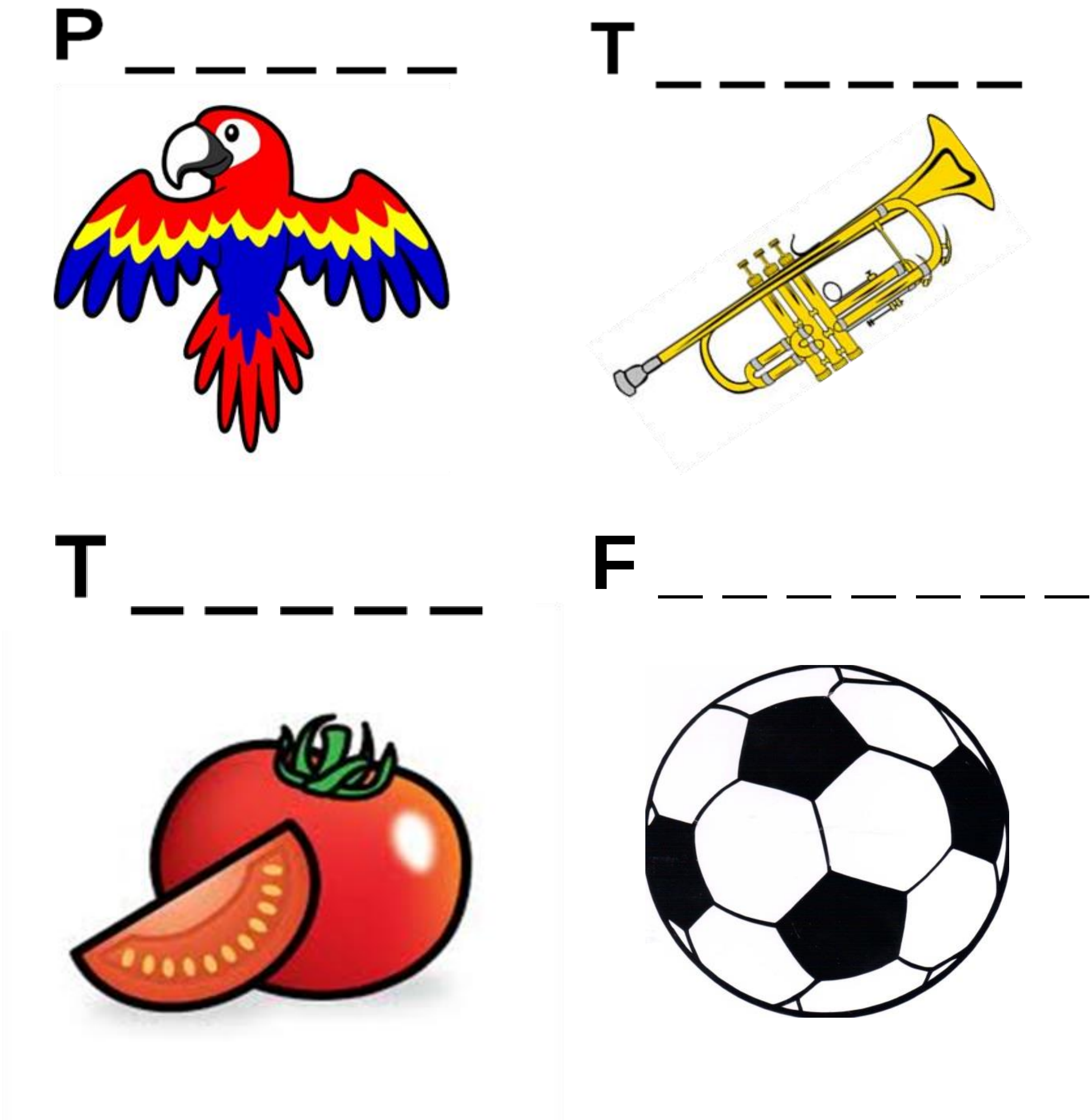

Figure 4.1: An example of the items used in the stress task of the speech rhythm-based intervention

Table 4.2: Word frequency per million for all target words in the stress task.

Word	**Frequency per million**
balloon	314
blanket	41
butterfly	122
camera	160
candle	24
carrot	5
chicken	154
chocolate	105
coffee	32
computer	200
cupcake	5
crayons	14
dinner	170
dinosaur	238
finger	68
flower	127
football	138
kettle	22
money	365
monkey	276
paper	365
parrot	130
pencil	30
potato	27
rabbit	441
shower	22
sofa	16
table	241
teddy	206
television	187
tomato	19
trumpet	16
vegetables	54
window	560
yoghurt	16

4.2.2 The Intonation Task

Intonation was trained in a similar way to stress, with 5 items being presented to participants each week over a 10 week period, plus an additional 5 items being used in each of the pre-, post-, and delayed post-test assessments. Figure 3.2 illustrates examples of the items used in the intonation activities, and a full list of items and weekly schedule is included in Appendix 1.

In the intonation task, children were again presented with a picture and matching pre-recorded verbal stimuli for each item, and were asked to listen carefully to the voice that was speaking. For each item, the verbal stimulus either had a constant tonal pattern (representing a statement), or had a rising pattern of intonation (representing a question). Children were asked to identify whether "Janet" was either telling them something about the picture (constant tone) or asking them a question about it (rising tone). Evidence to support the idea that a rising tone indicates a question comes from Crystal (1969), who claimed that a particular question including an interrogative word such as "how" tends to be pronounced with a falling tone, whereas a general question with no interrogative tends to be pronounced with a rising tone (Crystal, 1969: 3). Since the phrases used in this intervention had no interrogatives, it was assumed that when pronounced with a rising tone they would indicate a question. As with the stress task, children gave their answers to the intonation task using response cards, and were this time given a response card depicting a large question mark. Each time they thought they heard a question they were required to hold up the question mark, turning it over on the table if they thought the tonal pattern was constant and therefore represented a statement.

Please see Table 4.3 for a full word list of items in the intonation tasks. As with the stress items, the data for the intonation stimuli were analysed following initial pilot work in order to place the items in order of difficulty and arrange them in groups of equal difficulty level for each week. Please note that the items presented in the table below are in alphabetical order and not the order in which they were administered. A full list of items per week is included in Appendix 1 and standardised instructions are provided in Appendix 3.

Figure 4.2 An example of the items used in the intonation task of the speech rhythm-based intervention

Table 4.3: Word frequency per million for all target items in the intonation task

Stimuli	Target Word	Frequency per million
school bag	bag	392
Bedtime	bedtime	32
read book	book	541
Breakfast	breakfast	173
mummy's coat	coat	176
Coffee	coffee	32
play on the computer	computer	200
dinner time	dinner	170
play football	football	138
eat your fruit	fruit	133
having fun	fun	573
play game	game	160
bake gingerbread	gingerbread	149
Laughing	laughing	105
Listen	listen	114
Monday today	Monday	65
your name	name	306
Painting	painting	154
draw a picture	picture	273
Playtime	playtime	57
listen to the radio	radio	116
raining outside	raining	57
build a rocket	rocket	141
daddy's shoes	shoes	268
go shopping	shopping	200
Shower	shower	22
sit on the sofa	sofa	16
go to the station	station	133
sunny outside	sun	479
go swimming	swimming	154
cup of tea	tea	503
watch television	television	187
push the trolley	trolley	151
washing up	washing	157
look out the window	window	560

4.2.3 The Timing Task

Timing was the final component making up speech rhythm as a whole, and was assessed and trained in a similar way to stress and intonation as illustrated above. As with the other two tasks, the timing task involved the administration of picture and sound stimuli to children each week. However, the timing task followed a slightly different format to the other two tasks, and was similar to The Compound Nouns Task (Whalley and Hansen, 2006). Each visual item contained three pictures separated with a single line, illustrating the difference between one word and two, i.e. on one side of the line were 2 pictures (e.g. paint and brush) and on the other side of the line was one picture (e.g. paintbrush). As in The Compound Nouns Task, children were required to distinguish between the two options and identify the picture(s) corresponding to the pre-recorded verbal stimuli presented through the computer. Again, children used response cards to give their answer, and were this time presented with two response cards, one with a number “1” on and one with a number “2” on. If they thought what they heard represented one item they were to hold up the card with “1” on it, and if they thought they heard two separate words they were to hold up the card with “2” on it. Examples of the items for the timing task are illustrated in Figure 4.3, and a full list of items and weekly schedule is included in Appendix 1.

As with the stress and intonation tasks, there were 35 timing items in total, with 5 items administered in each of the ten weeks in the intervention period and an additional 5 items being administered in the pre-, post-, and delayed post-test assessments of speech rhythm sensitivity. A complete list of these items is presented in table 4.4. Please note that the items presented in the table are in alphabetical order and not in the order they were administered. A full list of items per week is included in Appendix 1 and standardised instructions are provided in Appendix 4.

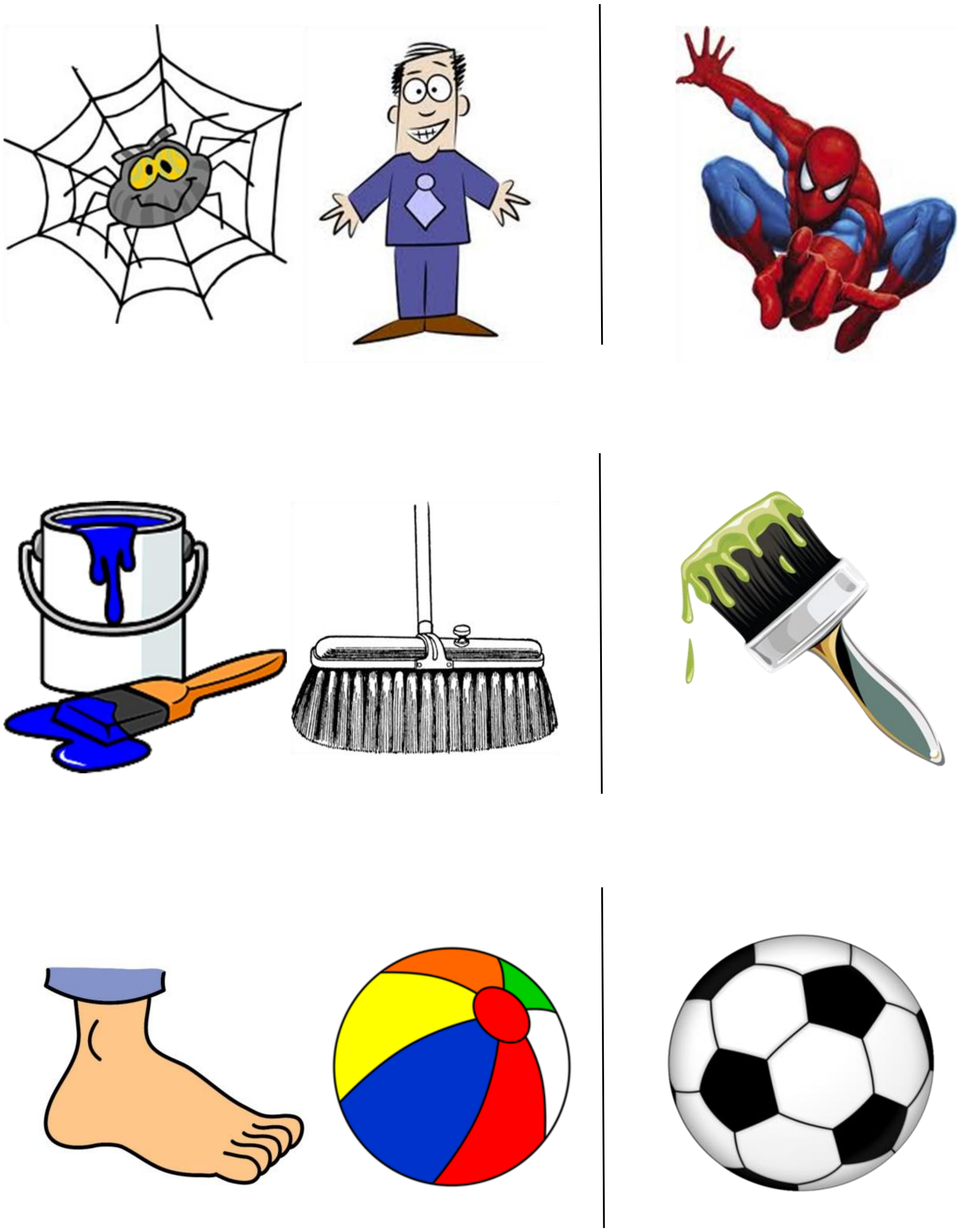

Figure 4.3: An example of the items used in the timing task in the speech rhythm intervention

Table 4.4 Word frequencies per million for each item in the timing task

Compound Noun	Frequency per million	First noun	Frequency per million	Second noun	Frequency per million
apple pie		apple	219	pie	89
armchair	11	arm	51	chair	208
basketball	5	basket	154	ball	346
batman		bat	122	man	1439
blackbird	16	black	360	bird	287
breadstick		bread	224	stick	146
butterfly	122	butter	87	fly	422
chocolate cake		chocolate	105	cake	254
cowboy	14	cow	333	boy	844
cupcake	5	cup	216	cake	254
doorbell	8	door	857	bell	162
earring		ear	103	ring	95
fish fingers		fish	784	fingers	89
football	138	foot	135	ball	346
greenhouse	70	green	538	house	1880
hairbrush	30	hair	243	brush	119
horse shoe		horse	441	shoe	105
icecream		ice	254	cream	133
ice lolly		ice	254	lolly	14
jacket potato		jacket	41	potato	27
jelly baby		jelly	146	baby	790
jellyfish	5	jelly	146	fish	784
keyring		key	581	ring	95
lipstick	8	lip	16	stick	146
paintbrush	11	paint	260	brush	119
pancake	70	pan	38	cake	254
rainbow	230	rain	373	bow	27
sandcastle	24	sand	178	castle	297
spiderman	5	spider	70	man	1439
starfish	16	star	81	fish	784
sunflower	3	sun	479	flower	127
sunglasses	8	sun	479	glasses	124
toothbrush	14	tooth	65	brush	119
twenty one		twenty	27	one	3069
wheelchair	22	wheel	51	chair	208

4.2.4 Other issues to consider

Regardless of the careful selection of words for this task, there were still issues that needed to be addressed in the planning of the intervention schedule. Due to the presentation of pictures in the tasks, vocabulary could be an over-riding issue which could interfere with performance on the tasks. In order to account for this, vocabulary was assessed as a control measure to eliminate any effect of a child's vocabulary knowledge on their recognition and understanding of items on the scale. Secondly, although phonological awareness has been shown to be related to speech rhythm sensitivity (e.g. Wood, 2006), it is possible that children's level of phonological awareness could influence their performance on these tasks. As a result, phonological awareness was also assessed so that it too could be used as a control variable in any analyses.

In addition to the training materials, if children were to respond to the training programme designed for this intervention, it was crucial that the word games captured their attention and were fun for the children such that they could engage with the materials and enjoy their contact with the games. It was also important to consider the repetitive nature of the tasks as the children were expected to complete each of these three activities once a week for a 10 week period. It was therefore important to consider other activities which could link with the intervention and could break up the experience of the intervention a little in order to make it less repetitive and engaging not only for the children but also for the administrator. If the tasks were to be implemented by teachers as part of a programme of reading intervention, it was important that there were activities which teaching staff could engage in and can link to their normal classroom activities with the children. In order to achieve this, a group story time element was also added to the children's weekly experience as part of the intervention programme.

4.2.5 Group Storybook Reading

In addition to the intervention materials explained above, children in each intervention group in Study 1 also participated in group storybook reading with the investigator once per week for 15 minutes. The books used for this activity in the speech rhythm intervention were from the 'Hairy MacLary and friends' series by Lynley Dodd. These texts were selected because they followed a highly regular rhythmic structure. However, the sentences in these stories, as well as being highly rhythmic, also rhymed. As rhyme (rime) awareness is a feature of segmental phonological awareness that is known to be associated with reading outcomes, and this project was concerned with training sensitivity to rhythm rather than rhyme, the final words of the sentences were changed so that they maintained the rhythmic structure of the utterance but there was no rhyme at the end of pairs of sentences. The children were given three options which the group were required to think about and choose the one that fitted the overall rhythm of the passage best. For example, they might hear:

> 'Slinky Malinki
>
> was blacker than black
>
> a stalking and lurking
>
> ..."

Options were, for example, (a) adventurous cat, (b) scary cat, or (c) misbehaving cat.

4.3 Selection of Phonological and Control Interventions

Additional interventions were also employed in the research studies, so that the effects of the speech rhythm-based intervention could be compared to treated control groups. In Study 1, the effects of the speech rhythm-based intervention were compared to those of a traditional phonological awareness-based intervention and a maths-based control intervention. The maths-based control was selected to provide educational benefit to children in this group, but to benefit them in a way that was not linked to literacy. This was also beneficial because if we did not treat the control group, these children would have lacked exposure to the research team and we might have experienced a Hawthorne effect in the assessment weeks. In Study 2, the effects of the speech rhythm intervention were compared to a phonological awareness-based intervention and a semantic control intervention. The semantic control was selected for study 2 because we were aware that all children taking part in this study had reading difficulties, and it would therefore be unethical to provide them with training that was not based on developing their literacy skills. A semantic intervention was therefore tailored to train children in this group on language-based skills that were not directly linked to phonology.

4.3.1 Phonological Awareness Intervention for Study 1

The phonological awareness-based intervention was included to provide a comparison between children who received the speech rhythm intervention and children who received traditional phonological-based reading tuition similar to what they would receive in the classroom once they begin formal reading tuition. Children receiving the speech rhythm intervention were compared to children receiving the phonological intervention in terms of any improvements in their reading performance and other literacy skills, to determine if effects of speech rhythm training were equivalent to those observed by more traditional methods. The phonological awareness-based intervention for Study 1 was adapted from the The Sound Linkage Programme (Hatcher, 2000). It was difficult to determine the effectiveness of an intervention programme at the pre-reader stage, as there is little evidence of interventions being used in this age range. However, certain activities within the Sound Linkage programme were thought to be appropriate for beginning readers, such as rhyming games and identifying letters. Details of this intervention are provided in Appendix 5.

It should also be noted that the children who took part in both of the studies involved in this thesis were simultaneously being trained via additional methods of reading tuition. In study 1, all participating children were being exposed to the Jolly Phonics intervention as part of their general classroom literacy tuition. Jolly Phonics trains children on the basic aspects of segmental phonological awareness, teaching children how to map spoken sounds onto their orthographical counterparts, i.e. “letters and sounds”. The Sound Linkage intervention employed as the phonological awareness intervention in Study 1 was therefore far more advanced than what the children were already receiving in class in terms of the range of activities and skills that were trained. It is therefore important to note that the interventions employed as part of this study were additional to any literacy tuition the participants were receiving in class.

In order to keep the intervention groups equivalent as far as possible throughout the training procedures, an additional group activity session was incorporated to the phonological intervention group for Study 1, to be administered on a weekly basis throughout the intervention period. The phonological group would receive phonic book reading activities with the investigator for 15 minutes per week, together with other children receiving this intervention in their class.

4.3.2 Mathematic Control Intervention for Study 1

An additional mathematics-based intervention was employed as a control intervention in Study 1. It was important that all groups would benefit from training as they would be removed from their normal classroom activities to take part in the research, and so educational benefits were essential for participation to be worthwhile. However, it was also important that the intervention selected was unlikely to impact the children's reading attainment, in order to provide a comparison control in which the children had the same amount and type of contact with research team as the children in the two reading treatment groups would receive. The alternative to this treated control would be a 'business as usual' condition, in which children would not receive any additional training to that which they already receive in class. However, this would have disadvantages such as a Hawthorne effect in the assessment weeks due to a lack of exposure to the research team, and irregularities between treatment groups. The mathematics intervention was therefore designed purposefully for the first study, in order to train children on their mathematical ability with no link to reading. The maths-based intervention materials were based on activities from the Numicon programme (Atkinson, Tacon and Wing, 1999), comprising number recognition, matching colours, matching shapes, simple addition and subtraction, and domino games. Further details of this intervention are included in appendix 6.

As with the phonological group, an additional group activity session was incorporated to the maths intervention group for Study 1 to keep groups as equivalent as possible during the intervention period. This was administered on a weekly basis throughout the intervention period, with each group session lasting approximately 15 minutes. Children received age-appropriate group mathematic activities selected from the cbeebies© website, and completed the activities together with the investigator and other children in the maths intervention group who were in the same class.

4.3.3 Phonological Awareness Intervention for Study 2

The phonological awareness intervention materials used for Study 2 were based on the Jolly Phonics programme, which is popular within English schools. The phonologically-based intervention was changed from the Sound Linkage programme administered in Study 1 because results showed that children did not make the progress expected in phonological awareness, and this might have been down to the way Sound Linkage activities had been selected for use with young children for the purposes of that study. Jolly Phonics, in comparison, has been supported by Stuart (1999) and Bowyer-Crane et al (2007) who both found that Jolly Phonics was able to accelerate reading performance beyond a control intervention. This method of tuition is often used with children from reception upwards and was therefore seen as an appropriate intervention for children who may have reading difficulties and therefore have low levels of literacy attainment. Further details of this intervention are included in appendix 7.

For reasons beyond control, it was not possible to administer the group storybook reading activities in study 2. This was due to the nature of the study whereby only the struggling children were involved in the interventions. It was therefore not fair on the rest of the class to administer story time activities in the classroom with only a small proportion of the class. In addition, in some classes there were only a very small number of children who took part in the study, and these children would therefore not have had the same benefit from the activities as children in other schools or classes where there was a larger group of children taking part in the study. The phonological and control interventions in study 2 were not, therefore, accompanied by additional group activities. Nevertheless, it is emphasised that it would be easy to incorporate group activities in the event of the interventions being administered to the whole class.

As with study 1, it should also be noted that the children who took part in Study 2 were also receiving some existing literacy tuition as part of their general teaching. The children in Study 2 were already in receipt of training on the Read Write Inc. programme, which comprises an entire literacy programme that is adaptable to the child's ability level. The Jolly Phonics intervention employed as the phonological awareness intervention in study 2 was therefore more basic than that which the children were already receiving in class. As with that in Study 1, the interventions administered during Study 2 were additional to training which they were already receiving in class.

4.3.4 Semantic Control Intervention for Study 2

A different approach was also taken for the control group in Study 2, as in Study 1 it was evident that the mathematics control had no connection with literacy. The control condition in Study 2 therefore took a semantic approach to tuition, teaching children about word meanings, etc., and therefore relating to literacy but having no direct link with reading. This was appropriate because we were aware that all of the children taking part in study 2 had reading difficulties, so it would be unethical to administer an intervention with no links to literacy, particularly as the children were taken out of the classroom to complete these activities. Activities in this intervention included category games, where children had to think of 5 items in a category each week, for example school lessons, plants, or fruit; synonym games, where children had to name words that meant the same as a target word, for example, happy, sad, hot, cold, etc.; and word and picture matching tasks.

As with the speech rhythm-based intervention, all of the control interventions were administered in weekly sessions in small groups of three, together with the administrator, with each session lasting approximately 15 minutes. Children received a score out of 15 per week for each intervention, so that the groups were comparable in terms of scoring and progress throughout the intervention period. Further details of this intervention are included in appendix 8.

4.4 Recruitment and Ethical Considerations

All of the studies in this thesis were conducted in accordance with the British Psychological Society's code of conduct, and all received ethical approval from the Coventry University Ethics Committee.

4.4.1 Pilot Study

Participants for a pilot study were all selected from reception classes at a single primary school in the Derby area, where forty reception children were recruited, all aged between 4 years 10 months and 5 years 9 months at the time of participation. The purpose of this pilot study was to determine whether the vocabulary of reception children would allow them to identify with the objects in the pictures which were intended for use in the speech rhythm-based intervention. This was important because if children did not have the names of these objects in their vocabulary, they would not be familiar with the prosodic features of these words and would therefore not understand the intervention materials. All of the pictures corresponding to the stress, intonation and timing audio stimuli were presented to each of the 40 children, who were required to verbally identify the name of the objects in the pictures. This enabled us to create a final list of stimuli and to remove any stimuli that were not recognised by children in this age group.

4.4.2 Recruitment for the Main Studies

For Study 1, 90 reception children were recruited from two primary schools in the Derby area, aged between 4 years 1 month and 5 years 0 months at the time of their first participation session. Participants in study 2 were recruited from year 3 classes at three primary schools in the Coventry area, and were all aged between 7 years 0 months and 8 years 7 months at the time of their first participation session.

4.4.3 Ethical Considerations

Ethical considerations were adhered to during recruitment of participants and the data collection process for all studies. Evidence of ethical approval for Study 1 is included in Appendix 9, and evidence of ethical approval for Study 2 is included in Appendix 19.

The head teachers of participating schools were all fully briefed regarding the research in the form of a letter (see Appendix 10 for Study 1 and Appendix 20 for Study 2) and were encouraged to contact the lead researcher regarding any questions or queries they may have. Head teachers were provided with additional information regarding the research in the form of a participant information sheet (see Appendix 11 for Study 1 and Appendix 21 for Study 2), and were required to fill out an official consent form should they wish their school to participate in the research (see Appendix 12 for Study 1 and Appendix 22 for Study 2). This procedure was carried out separately for each study.

Following consent from the head teacher of participating schools, all parents of qualifying children were sent information on the project in the form of a letter similar to that sent to the head teacher (see Appendix 13 for Study 1 and Appendix 23 for Study 2). All parents were also provided with a participant information sheet explaining details of the study (see Appendix 14 for Study 1 and Appendix 24 for Study 2.). For Study 1, parents were required to send back a completed consent form should they wish their child to participate in the research (see Appendix 15). This was an opt-in recruitment procedure and so children whose parents had not returned their consent form by the start of the data collection process were not able to take part. For Study 2, an opt-out procedure was used for consent, whereby parents only had to send back the consent form if they did NOT wish their child to take part in the research (see opt-out form in Appendix 25). If parents did not return the form by a given date, it was assumed that they consented to their child taking part. This was deemed to be an appropriate method of recruitment for the second study, because the intervention was targeted at children who had already performed at a level below that which we would expect for a child of their age group on a standardized reading test, and so it was seen to be appropriate and beneficial from the school perspective to have as many children as possible receiving additional training that was predicted to boost their literacy performance and benefit academic achievement. Opt out consent for literacy research of this type is permitted in the context of the Coventry University Ethics Governance.

All head teachers and parents of participating children were reminded of their right to withdraw from the research at any time, and were assured that there would be no repercussions should they wish to withdraw their child/school’s data from the experiment. All parents and teachers were provided with contact details of the lead researcher and supervisory team. In addition, all teachers and parents were reminded that additional information about the project would be available to them upon request. In addition to receiving informed consent from teachers and parents of participating children, the children themselves were verbally briefed in terms that they could understand and verbally assented prior to their participation in the research and this procedure was followed prior to each training session (see briefing in Appendix 16 for Study 1 and Appendix 26 for Study 2).

It was ensured that all participants and details of participating schools remained anonymous and untraceable at all times, and that there were no links to individual schools or children in the written output. Raw data were stored securely in a filing cabinet in a private room at Coventry University in order to ensure security of sensitive information. It was ensured that teachers, parents and any associated parties had access to contact details should they have any further questions or issues to raise in relation to the project. The head teacher and parents were all debriefed at the end of the project in the form of a letter (see Appendix 17 for head debrief for Study 1; Appendix 18 for parental debrief for Study 1, Appendix 27 for head debrief for Study 2; and Appendix 28 for parental debrief for Study 2). All children who took part in the studies also received a certificate of participation to thank them for their hard work (see Appendix 29).

4.5 Test Battery

Most of the activities and assessments mentioned here were used in multiple studies in this thesis. In order to avoid repetition, all measures are described in detail below and are only referred to briefly in later chapters relating to individual studies. The assessments included in the studies in this thesis (with the exception of the newly developed speech rhythm assessment and intervention) were selected for their common usage in the field of reading research, because they would provide standardized measures of reading skills and allow for close comparisons with existing literature.

4.5.1 Single Word Reading Performance

4.5.1.1 Single Word Reading Ability (Study 1)

Single word reading performance was assessed in Study 1 using the British Ability Scales II Word Reading Subtest (Elliot, Smith and McUlloch, 1996), which assessed the number of words that a child could accurately read aloud to the administrator from a list provided. There were 90 words in total, split into nine blocks of ten words, and words increased in difficulty as the children progressed through the assessment. The children received one mark for each word they read correctly, and the test was discontinued if the child made eight or more errors in a block of ten words. As the children were all pre-readers at the recruitment stage for Study 1, the majority of children were likely to demonstrate low levels of competency at pretest, but it was expected that children would be able to read at least some of the words on the assessment by the time they reached the post-test assessment following the intervention period. All children were included in the intervention regardless of whether they could read any words at the pre-test. When it came to data analysis, these children were screened out, but this made no difference to the results so the decision was made to keep them in. An example of the score sheet is included in Appendix 30.

4.5.1.2 Single Word Reading Ability (Study 2)

The single word reading test used in Study 2 was the Diagnostic Test of Word Reading Processes (Forum for Research in Literacy and Language, Institute of Education, 2012), which assesses children’s ability to identify and correctly decode three types of words: real words, exception words and non-words. There were two practice items in the non-word reading test, and the 90 test items were split into three sub-sections, including 30 non-words, 30 real words, and 30 exception words. Each set increased in difficulty as the children progressed through the assessment. Children were required to read the words aloud to the administrator from the list provided and received one mark for every correct response given. Each set was discontinued if children made five consecutive errors. The decision was made to change the word reading assessment in study 2 because the BAS only focused on real word reading, whereas the DTWRP assessed three different types of word reading and was therefore judged to be more comprehensive. An example of the score sheet is included in Appendix 31.

4.5.2 Reading Comprehension (Study 2)

The children in Study 2 were assessed for their level of reading comprehension using the York Assessment of Reading Comprehension (Snowling, Stothard, Clarke, Bowyer-Crane, Harrington, Truelove, Nation and Hulme, 2009) Passage Reading Test. This assessment was not suitable for use with the beginning readers in Study 1, but was included here as it has been shown that speech rhythm sensitivity is usually related to performance on measures of reading comprehension (see Cohen, Douaire and Elsabbagh, 2001; Miller and Schwanenflugel, 2008; Schwanenflugel et al, 2004; Whalley and Hansen, 2006). To complete the assessment, children were required to read a passage aloud to the administrator from a printed booklet. Their starting passage was selected in accordance with their single word reading ability. Children were timed reading the passage aloud to enable calculation of a score for reading rate, and the number of errors made on each passage were recorded on a pupil record form to give a measure of reading accuracy. Children were then asked a series of comprehension questions from a list on the record form, and were required to answer them using information from the passage text. Appropriate answers to each question were listed in an accompanying booklet for use by the administrator. Children received one point for every correct response given, and continued onto the next passage if they answered five or more questions correctly from a possible eight. The test was discontinued when children gave less than five correct responses to comprehension questions on a single passage. Comprehension scores were calculated using the test manual. An example of the score sheet is included in Appendix 32.

4.5.3 Phonological Awareness

Phonological awareness was assessed using a selection of assessments taken from from the Phonological Assessment Battery (Frederickson, Frith and Reason, 1997), namely: rhyme detection, alliteration detection and spoonerisms. Assessments of phonological awareness were important because one of the interventions focused on training children's phonological awareness in each study. These assessments were therefore used as an outcome variable. Phonological awareness, as measured by these assessments, was also controlled for when analysing the ability of the speech rhythm intervention to improve reading performance.

4.5.3.1 Rhyme Detection

The rhyme detection subtest was used to assess the children's sensitivity to rhyme. The children heard three words read aloud by the administrator from a standardized list; two of which were rhyming words, and a third distracter word. The children were required to identify the two rhyming words from the three provided, for example, they might be presented with “made, hide, fade”, and should correctly identify “made” and “fade” as the two rhyming words to receive a correct mark. There were three practice items and twenty-one test items in total, which increased in difficulty as children progressed through the assessment. There were 12 items in the first set and 9 items in the second set, and children were only eligible to continue to the second set if they answered at least 9 of the items correctly in the first set. No feedback was provided during administration of the test items. An example of the score sheet is included in Appendix 33.

4.5.3.2 Alliteration Detection

The alliteration detection subtest was administered as an assessment of children’s sensitivity to alliteration. As with the rhyme detection test described above, children heard three words read aloud by the administrator from a standardized list. Two of the words in each item list had the same first sound, and children were required to correctly identify these in each item. For example, they might be presented with “ship, fat, fox”, and should correctly identify “fat” and “fox” as the two words with the same first sound. There were three practice items for the first set and two practice items for the second set, with five experimental items per set of increasing difficulty. Children were only eligible to pass onto the second set if they answered at least three of the items in the first set correctly. No feedback was given during administration of the test items. An example of the score sheet is included in Appendix 34.

4.5.3.3 Spoonerism Detection (Study 2 only)

The spoonerism detection subtest of the Phonological Assessment Battery was administered as a measure of children's sensitivity to, and awareness of, spoonerisms. There are two parts to this assessment, however, only part 1 was administered as the second part was determined to be too difficult for the children who took part in the studies described here. In part 1 of this assessment, children were presented with a word spoken aloud by the administrator, for example "cot", and were required to replace the first letter sound with a different sound, for example "what is "cot" with a "/g/ sound?" – in this example, the correct response would be "got". There were three practice items in which children were given feedback on their answers, followed by ten test items. An example of the score sheet is included in Appendix 35.

4.5.4 Speech Rhythm Sensitivity

Speech rhythm sensitivity was assessed using an assessment tool similar to the speech rhythm intervention materials described in section 3.2. The assessment was made up of three sub-sections, measuring children's sensitivity to the individual components of stress, intonation and timing. There were five items in each of the sub-sections, and children received one point per correct response given, giving a total possible score out of 15. It is important to note that the items used in each of the pre-, post- and delayed post-test assessments were all different, and additionally, these assessment items all differed from the items used in the speech rhythm intervention sessions. The pre-test score sheet for the speech rhythm sensitivity assessment is included in Appendix 36, the post-test score sheet is in Appendix 37, and the delayed post-test score sheet is in Appendix 38.

4.5.4.1 Stress Sensitivity

Sensitivity to stress was assessed using an assessment method similar to that employed in the speech rhythm intervention. Children were presented with a picture (for example, a parrot) and corresponding pre-recorded audio stimuli which either had the correct stress pattern, (e.g. PARrot), or a reversed stress pattern (e.g. parROT). Children were required to identify whether the stress pattern was correct or incorrect for each item. There were five items in total and children received one point for every correct response given. Standardised instructions are provided in Appendix 2.

4.5.4.2 Intonation Sensitivity

Sensitivity to intonation was assessed by again using an assessment method similar to that employed in the speech rhythm intervention. As with the stress sensitivity assessment, children were presented with a picture (for example, a rain cloud) and corresponding pre-recorded audio stimuli which, this time, either represented a question (e.g. raining outside?) with a rising tonal pattern, or a statement (e.g. raining outside) with a constant tonal pattern. Children were required to identify whether the audio stimuli represented a question or a statement. There were five items in total and children received one point for every correct response given. Standardised instructions are provided in Appendix 3.

4.5.4.3 Timing Sensitivity

Sensitivity to timing was also assessed using an assessment method similar to that in the speech rhythm intervention. This time, children were presented with two picture options and corresponding pre-recorded audio stimuli. The stimuli for this task were all based on compound nouns, and children were presented with a picture which represented, for example, a paintbrush, and a second picture representing a pot of paint and a brush as two separate items. The corresponding audio stimuli would either represent “paintbrush” (one word), or “paint, brush” (two words). Children were required to identify whether the audio stimuli represented one word (picture a) or two words (picture b). There were five items in total, and children received one point for every correct response. Standardised instructions are provided in Appendix 4.

4.5.5 Vocabulary (Study 1 only)

In Study 1, receptive vocabulary was assessed using the British Picture Vocabulary Scales III (Dunn, Dunn, Whetton and Burley, 1997). This was used to provide a measure of general language ability and was used as a control variable in the statistical analyses to account for individual differences in language. The children were presented with four possible picture options for each item, and heard a word spoken aloud by the administrator. Children were required to select the picture which best illustrated the word spoken by the administrator by pointing to the picture they believed to be correct. There were twelve items in each word set, and items became increasingly difficult as children progressed through the assessment. Children received one point for each correct answer, and the test was discontinued when children made eight or more errors in a set of twelve items. An example of the score sheet is included in Appendix 42.

4.5.6 General Cognitive Ability (Study 2 only)

In Study 2, general cognitive ability was measured using the Wechsler Abbreviated Scale of Intelligence II (Wechsler, 2011) as an age appropriate measure of individual differences in general language ability. The general intelligence test comprised of four subsections, measuring children's ability to perform on block design, vocabulary, matrix reasoning and similarities. Children received a raw score for each of the four assessments involved in this scale. An example of the score sheet is included in Appendix 43.

4.5.6.1 Block Design

In the block design test, children were presented with two six-sided blocks, each of which had two red sides, two white sides, and two sides which were half red and half white. Children were presented with a picture which showed a design made up of two blocks, and an example of how to create the design, put together by the administrator. Children were required to reproduce the design using their own blocks. The administrator only provided their own example for the first four items, after which children were required to create the block design using only the picture for reference. Items increased in difficulty as children progressed through the assessment, and children were timed completing each item, receiving marks depending on the time each item took them to complete. The assessment contained thirteen items, but assessment was discontinued after two consecutive scores of zero.

4.5.6.2 Vocabulary

In the vocabulary assessment, children were presented with a picture (for example, a fish) and were required to describe the item in the picture to the administrator. After the first three items, the items were presented as written words rather than pictures (for example “shirt”), and words increased in difficulty as children progressed through the assessment. Responses were recorded on the record form by the administrator and children received a score of 0, 1, or 2, depending on the accuracy of their description. The test contained thirty-one items in total, but testing stopped at a level which was dependent on age group; in this experiment, children were aged 7-8 years, so testing was terminated at item 25. Most children did not reach this point, however, and testing was discontinued after three consecutive scores of zero.

4.5.6.3 Matrix Reasoning

The matrix reasoning assessment tested children on their ability to identify the next item in a sequence from a possible five options. Children were presented with a visual pattern of items, one section of which was blanked out and replaced with a question mark. Children were required to identify which of the five possible options should fill the missing space, and were awarded one point for each correct response given. There were two practice items, followed by thirty test items in total, but children of age 8 and below stopped after item 24. The assessment was discontinued before this point if children made three consecutive errors.

4.5.6.4 Similarities

In the similarities assessment, children were firstly presented with two pictures (for example, a pig and a dog) and were asked to identify a third item from a possible four that was also similar to the two presented (options included, for example, a candle, an umbrella, a cow and a boat). In this example, children should correctly identify the cow as being similar (i.e. they are all animals). After item 3, children were presented with words spoken aloud by the administrator instead of pictures, and were asked to identify what was similar about the two items. For example, they might be presented with “green” and “blue”, where the correct response would be “colours”. There were twenty-four items in total, but children aged 8 or below stopped at item 22. Children were given a score of 0, 1, or 2 for each item, depending on the accuracy of their response, and testing was discontinued if children made three consecutive errors.

4.6 Data Collection Resources

For both studies, the new speech rhythm-based reading intervention was administered by using pre-recorded verbal stimuli which were played to participants through external speakers from a laptop computer. There were five items per week, plus an additional five items in each of the pre-, post- and delayed-post test assessments, for each of the three assessments of speech rhythm sensitivity. This gave a total of sixty-five items per task (195 items in total). In addition to the audio sounds, 35 picture cards were created for use in each of the three conditions of the speech rhythm intervention, giving a total of 105 picture cards. Each picture was used twice throughout the course of the intervention, because there were two possible audio options for each picture (e.g. picture of a parrot + “parROT” in one week, and a picture of a parrot + “PARrot” in another week). Score sheets were created for the speech rhythm assessments and intervention weeks and these can be seen in appendix

4.7 Chapter Summary

The aim of this chapter was to provide a review of the possible methodologies for a new speech rhythm-based reading intervention. From reviewing appropriate measures and assessments in the current literature, a new speech rhythm based reading intervention has been developed for use in the research studies included in this thesis. This intervention is described in detail in this chapter and examples of the stimuli are presented. Methods of recruitment are described with reference to ethical considerations, assessment tools have been outlined and data collection equipment has been described. The following chapters of this thesis will describe, explain and analyse the two main studies that were carried out to evaluate the effectiveness of the new speech rhythm-based reading intervention outlined in Section 4.2.

Chapter 5: Study 1

A Randomised Controlled Trial of the Immediate and Longer Term Effectiveness of a Speech Rhythm-Based Intervention for Beginning Readers

5.1 Introduction

The theoretical overview presented in Chapter 1 explains that a wide body of evidence exists supporting the use of traditional segmental phonological awareness-based approaches to reading tuition. However, it is also acknowledged that some children, and particularly those with reading difficulties, do not always respond to this type of intervention. A theoretical model has been proposed whereby speech rhythm sensitivity, and awareness of the suprasegmental elements of language, is necessary for the successful development of segmental phonological awareness, leading to successful reading development. Indeed, evidence has shown that speech rhythm sensitivity appears to be implicated in successful reading development (see Chapter 2.1), however the idea of speech rhythm-based tuition has only very recently been explored (e.g. Thomson et al, 2013; Bhide et al, 2013), and there are therefore very few descriptions of rhythmic-based interventions in the literature. Chapter 4.2 therefore outlined the development of a new type of reading intervention which focused on training children’s awareness of speech rhythm sensitivity as a possible way of enhancing children’s reading performance. Study 1 aimed to implement this intervention to a group of beginning readers to determine whether it was effective in enhancing the word reading performance of children who had not yet received any formal reading tuition. The study aimed to compare the effects of this intervention to those of a more established and traditional phonological approach to reading tuition, and those of a control intervention not expected to impact literacy outcomes (a mathematics intervention).

From this first study, the following questions were addressed:

1. Can a set of activities which aim to improve young children's sensitivity to speech rhythm benefit their reading development?
2. Can these activities result in gains that are equivalent to those achieved by a more traditional phonological-based intervention programme?
3. What are the observable characteristics of children who benefit the most from the speech prosody based intervention, and do they differ significantly from children who benefit from exposure to phonic-based interventions?

It was expected that the intervention would benefit children's reading development more than the control (maths-based) intervention would. However, if the intervention was to be deemed to be 'effective', it also needed to demonstrate levels of impact that were at least as good as those that could be achieved over the same period using more established methods of reading tuition. It was also of both practical and theoretical significance to examine the characteristics the children who benefited the most from a speech rhythm approach to intervention, and to know whether those children differed significantly on these characteristics from children who benefited from phonologically-based tuition.

It was predicted that a speech rhythm-based reading intervention would result in:

1. Significantly greater improvement in the early reading skills and phonological awareness of pre-school children than that of pre-school children who were exposed to a control (maths-based) intervention programme.
2. Equivalent gains in the early reading skills and phonological awareness of pre-school children (after controlling for individual differences in vocabulary) as that of children exposed to a traditional phonological-based intervention.

It was further predicted that the children who benefited significantly from exposure to the speech rhythm intervention would differ significantly from the children who benefited from exposure to the phonological awareness-based intervention on characteristics such as level of speech rhythm sensitivity, phonological awareness, level of reading ability for their age, and vocabulary level.

5.2 Method

5.2.1 Participants

Participants were 73 reception children, recruited from two primary schools in Derby, England, who were comparable in terms of locality, socio-economic status, number of pupils and academic achievement. The children ranged in age from 4 years 1 month to 5 years at Time 1, with a mean age of 4 years 6 months. All of the males (n = 31) and females (n = 42) who took part had English as a first language, and 5 of these had been exposed to a second language within their home environment. The mean standardised vocabulary score for the sample at Time 1, according to the British Picture Vocabulary Scales III (Dunn, Dunn, Whetton and Burley, 2011) was

100.66 (SD = 16.29). The mean word reading raw score according to the British Ability Scales II Word Reading Subtest (Elliot, Smith and McUlloch, 1996) was 2.48 (SD = 11.10), which is consistent with the age of the participants.

5.2.2 Materials

The following assessments were used in this study:

- The British Ability Scales II Word Reading Subtest
- The Rhyme and Alliteration Subtests of the Phonological Assessment Battery
- The British Picture Vocabulary Scales III
- The Speech Rhythm Sensitivity Assessment (using different items to those administered in the intervention)

In addition to these assessments, the following intervention materials were administered over a 10 week period:

- The Speech Rhythm-Based Intervention
- The Sound Linkage Phonological Intervention
- The Mathematic Control Intervention

5.2.3 Procedure

Participant information sheets and consent forms were sent out via the schools to the parents of all reception children. At Time 1, in September 2012, all participating children completed pre-test assessments of single word reading ability, phonological awareness, speech rhythm sensitivity and vocabulary. Children were then randomly allocated to one of three treatment groups, and received either the new speech rhythm-based intervention, the phonological comparison intervention, or the mathematics-based control intervention over ten weeks. The interventions were administered weekly between September and December 2012. Each training session lasted approximately 15 minutes (total training time = 150 minutes), in which children were trained in small groups of three together with the administrator. In addition to group training activities, all participants took part in weekly ‘carpet time’ activities in which all children in a given intervention group worked together on group activities as part of ‘story time’. Each carpet time activity lasted approximately 15 minutes and was administered to each group once per week (total carpet time activities = 150 minutes; total intervention time = 300 minutes). All assessments and intervention materials were delivered by myself. Following the final week of intervention in December 2012, all children completed post-test assessments of their single word reading ability, phonological awareness, speech rhythm sensitivity and vocabulary, in order to determine improvement rates between the pre-test (Time 1) and post-test (Time 2). Delayed follow-up data were also collected in March 2013, three months following the intervention phase (Time 3), in order to determine any longer lasting effects of the interventions. There were five assessments at each of Time 1 (September 2012), Time 2 (December 2012), and Time 3 (March 2013), with each assessment session lasting approximately 15-20 minutes. All children were assessed individually on a one-to-one basis with the investigator.

5.3 Results

5.3.1 Correlations

In order to determine how well each of the speech rhythm variables correlated with the various literacy measures before training, a correlation analysis was conducted on all pre-test data. This is presented in Table 5.1.

Table 5.1 Correlation matrix between the speech rhythm variables and outcome variables at Time 1 for all children

Variable	1	2	3	4	5	6	7	8
1. Stress Sensitivity	1.000							
2. Intonation Sensitivity	.133	1.000						
3. Timing Sensitivity	.096	.026	1.000					
4. Total Speech Rhythm Sensitivity	.641***	.630***	.549***	1.000				
5. BAS Word Reading	.344**	.047	.287*	.350**	1.000			
6. PhAB Rhyme Awareness	.273*	.040	.225	.286*	.298*	1.000		
7. PhAB Alliteration Awareness	.120	.057	.117	.194	.456***	.431***	1.000	
8. Vocabulary	.246*	.103	.303**	.362**	.467***	.534***	.410***	1.000

Notes: *p<.05, **p<.01, ***p<.001

BAS = British Ability Scales; PhAB = Phonological Assessment Battery. Vocabulary scores are BPVS raw scores.

As can be seen from Table 5.1, the speech rhythm measures were not significantly correlated with each other at the pre-test, suggesting that an improvement in one speech rhythm skill will not necessarily indicate an improvement in the other speech rhythm skills. All individual speech rhythm skills were, however, significantly correlated with overall speech rhythm sensitivity at the pre-test as would be expected. The correlations with reading show that sensitivity to stress was significantly correlated with word reading at the pre-test, as was sensitivity to timing, and overall speech rhythm sensitivity. Sensitivity to intonation, however, was not correlated with reading at the pre-test. In addition, sensitivity to stress appeared to be correlated with rhyme awareness at the pre-test, as was total speech rhythm sensitivity, but the speech rhythm measures did not appear to correlate with alliteration awareness at this stage. Vocabulary was correlated with both stress and timing as well as total speech rhythm sensitivity, but vocabulary was not correlated with intonation. Further correlations show that both phonological awareness measures (rhyme and alliteration) were significantly correlated with each other, and both were correlated with reading and vocabulary, and vocabulary was also correlated with reading. Additional correlation analyses were conducted on the post-test data for each group to determine whether this pattern of correlations had altered as a result of training. The correlation analyses for each of the three groups at post-test are presented in tables 5.2, 5.3, and 5.4.

Table 5.2 Correlation matrix between the speech rhythm variables and outcome variables at Time 2 for children who received the speech rhythm-based intervention

Variable	1	2	3	4	5	6	7	8
1. Stress Sensitivity	1.000							
2. Intonation Sensitivity	.237	1.000						
3. Timing Sensitivity	.092	.201	1.000					
4. Total Speech Rhythm Sensitivity	.605**	.760***	.617**	1.000				
5. BAS Word Reading	.391*	.292	.387*	.483*	1.000			
6. PhAB Rhyme Awareness	.152	-.014	.081	.084	.166	1.000		
7. PhAB Alliteration Awareness	-.125	.091	.309	.164	.425*	.003	1.000	
8. Vocabulary	.106	.098	.413*	.290	.368	.397*	.269	1.000

Notes: *p<.05, **p<.01, ***p<.001

Table 5.2 reveals that for children receiving the speech rhythm-based intervention, all individual components of speech rhythm were correlated significantly with overall speech rhythm sensitivity at the post-test. In addition, both stress sensitivity and timing sensitivity were correlated with word reading at the post-test as they were for all children at pre-test, although the correlation between stress sensitivity and reading was not as strong at the post-test as it was at Time 1. Furthermore, alliteration awareness continued to correlate with reading at Time 2, but rhyme awareness and vocabulary did not. As with the pre-test data, the individual components of speech rhythm sensitivity were not correlated with each other at the post-test for these children. We will now look at the post-test correlation matrix for children who received the phonological-awareness based intervention.

Table 5.3 Correlation matrix between the speech rhythm variables and outcome variables at Time 2 for children who received the phonological awareness intervention

Variable	1	2	3	4	5	6	7	8
1. Stress Sensitivity	1.000							
2. Intonation Sensitivity	.047	1.000						
3. Timing Sensitivity	.335	-.142	1.000					
4. Total Speech Rhythm Sensitivity	.774***	.430*	.566**	1.000				
5. BAS Word Reading	.295	-.233	.478*	.358	1.000			
6. PhAB Rhyme Awareness	.405*	.152	.240	.474*	.189	1.000		
7. PhAB Alliteration Awareness	.303	.055	-.019	.262	.400*	.475*	1.000	
8. Vocabulary	.333	.111	.195	.407*	.425*	.542**	.388	1.000

Notes: *p<.05, **p<.01, ***p<.001

Table 5.3 shows that all individual components of speech rhythm sensitivity continue to be correlated with overall speech rhythm sensitivity at the post-test for children who received the phonological awareness-based intervention. However, where the speech rhythm group continued to show a correlation between stress sensitivity and reading performance, and between overall speech rhythm sensitivity and reading at the post-test, children in the phonological awareness intervention group did not. The only measure of speech rhythm sensitivity that appears to be correlated with word reading at the post-test for these children is sensitivity to timing. Other significant correlations are present between rhyme awareness and total speech rhythm sensitivity, and between vocabulary and speech rhythm sensitivity. Vocabulary was also correlated with both reading and rhyme awareness, but not with alliteration awareness. Additionally, the two measures of phonological awareness (rhyme and alliteration) were significantly correlated at the post-test for children who were trained on the phonological-awareness based intervention, suggesting that improvement in one measure also indicates improvement on the other.

Finally, we should consider the correlation matrix for the children who received the maths-based control intervention, to determine if the correlations present between reading skills at the post-test for these children remain the same as the correlations at the pre-test. The correlation matrix for these children is presented in table 5.4.

Table 5.4 Correlation matrix between the speech rhythm variables and outcome variables at Time 2 for all children who received the maths-based control intervention

Variable	1	2	3	4	5	6	7	8
1. Stress Sensitivity	1.000							
2. Intonation Sensitivity	.096	1.000						
3. Timing Sensitivity	-.123	.070	1.000					
4. Total Speech Rhythm Sensitivity	.608**	.627**	.464*	1.000				
5. BAS Word Reading	.366	.078	.191	.297	1.000			
6. PhAB Rhyme Awareness	.392	-.035	.326	.396	.612**	1.000		
7. PhAB Alliteration Awareness	.291	.125	.107	.281	.656**	.717***	1.000	
8. Vocabulary	.324	.125	.446*	.494*	.575**	.611**	.551**	1.000

Notes: *p<.05, **p<.01, ***p<.001

Table 5.4 shows that similarly to the speech rhythm group and the phonological awareness group, all three individual components of speech rhythm were significantly correlated with total speech rhythm sensitivity at the post-test for children who received the maths-based control intervention. However, none of the speech rhythm measures were correlated with reading for these children, which is surprising given that both stress and timing, as well as total speech rhythm sensitivity, were significantly correlated with reading at the baseline (Time 1, see table 5.1). Furthermore, rhyme awareness, alliteration awareness and vocabulary were all significantly correlated with reading for these children. Additionally, both measures of phonological awareness (rhyme and alliteration) were significantly correlated with each other, and to vocabulary knowledge.

The gains observed in reading skills between Time 1 and Time 2 as a result of training shall now be explored. Table 5.5 shows the means and standard deviations at Time 1 and Time 2 on speech rhythm sensitivity, single word reading, rhyme awareness, alliteration awareness and receptive vocabulary measures for all intervention groups. It also shows the mean amount of change in score that took place between Time 1 and Time 2. It should be noted that there were no significant differences between the three intervention groups on any of the literacy measures at the pre-test.

Table 5.5 Mean changes between pre and post-test assessments for children in each intervention group

Variable	Group	Mean T1 score	SD	Mean T2 score	SD	Mean change T1:T2	SD
BAS Word Reading (/90)	SR	0.23	0.82	9.42	5.22	9.19	5.11
	PA	2.67	12.43	9.96	12.80	7.29	3.91
	Maths	5.55	16.17	11.00	17.06	5.45	3.86
Rhyme Detection (/21)	SR	5.50	3.87	6.81	3.57	1.31	3.76
	PA	4.38	4.07	5.33	4.01	0.96	4.57
	Maths	4.05	3.30	7.75	5.95	3.70	4.67
Alliteration Detection (/10)	SR	1.92	1.49	2.58	2.10	0.65	2.30
	PA	1.00	1.82	2.96	2.63	1.96	2.44
	Maths	2.00	2.97	2.70	3.16	0.70	1.42
Vocabulary	SR	62.31	11.84	70.69	12.49	8.38	6.20
	PA	62.88	18.21	69.58	13.63	6.71	9.44
	Maths	62.25	17.09	66.70	15.09	4.45	6.64
Speech Rhythm - Stress Sensitivity (/5)	SR	3.54	1.03	4.58	0.64	1.04	1.28
	PA	3.92	0.97	4.38	0.82	0.46	1.10
	Maths	3.85	0.99	4.05	0.94	0.20	1.20
Speech Rhythm - Intonation Sensitivity (/5)	SR	2.27	1.22	4.08	0.84	1.81	1.67
	PA	2.46	1.10	2.63	0.97	0.17	1.66
	Maths	2.45	0.89	2.45	1.05	0.00	1.34
Speech Rhythm – Timing Sensitivity (/5)	SR	4.08	0.93	4.69	0.88	0.62	1.10
	PA	4.08	0.97	4.67	0.76	0.58	1.02
	Maths	3.70	0.86	4.15	0.93	0.45	1.19
Speech Rhythm Total (/15)	SR	9.88	2.10	13.35	1.77	3.46	2.61
	PA	10.38	2.00	11.67	1.71	1.29	2.16
	Maths	10.00	1.56	10.65	1.84	0.65	2.32

Notes: BAS = British Ability Scales; T1 = Time 1; T2 = Time 2; Vocabulary scores are BPVS raw scores.

Initial examination of Table 5.5 shows some interesting trends. Firstly, the speech rhythm group showed the lowest mean word reading performance at time 1, but show the greatest improvement in reading over the other two groups. Secondly, when we look at the individual elements of speech rhythm sensitivity, intonation appears to be the skill that was least well developed at the pre-test, but yet all three elements of speech rhythm appear equally susceptible to training in this age group. Thirdly, the phonological awareness group did not seem to improve as rapidly as the other two groups on rhyme awareness, which was surprising given that this was a measure of the skill they were trained on. These findings will now be explored in more detail in relation to the research questions set out at the beginning of this thesis.

5.3.2 Can training on a speech rhythm-based reading intervention help to improve word reading performance?

It can be seen from Table 5.5 that participants in the speech rhythm group could read an average of 9.19 words more at Time 2 than they could at Time 1, compared to 7.29 words in the phonological awareness group and 5.45 words in the mathematic control group. Participants receiving the speech rhythm-based intervention additionally held the highest improvement rate out of all three groups on their vocabulary, stress sensitivity, intonation sensitivity and overall speech rhythm sensitivity.

Data were inspected to ensure they met assumptions for parametric testing. All improvement variables were normally distributed and there were no issues with skew or kurtosis. Initially, a simple one-way ANOVA was conducted to compare the degree of change on each of the dependent variables between the three experimental groups. This showed that there was a significant main effect of treatment group membership on their change in word reading performance between Time 1 and Time 2, $F(2, 70)=3.588$, $p=.033$, $\eta=.093$. The participants in this study, although all in the same school year, ranged from just 4 years, to almost 5 years. In order to control for individual differences that might occur due to the age of the participants, age was used as a control variable. This difference in reading improvement also remained after controlling for age, $F(2, 70)=3.991$, $p=.023$, $\eta=.104$, and after additionally controlling for individual differences in vocabulary, $F(2, 70)=4.013$, $p=0.23$, $\eta=.106$. Tukey HSD post hoc analyses showed that the speech rhythm group outperformed the control (maths) group on their improvement in word reading ($p=.030$) as expected, and that there was no significant difference between the speech rhythm group and the phonological awareness group ($p=.199$), nor between the phonological awareness and maths control group ($p=.619$). Further to this, there appeared to be no significant differences between any of the groups on their improvement in rhyme awareness, $F(2, 70)=2.436$, $p=.095$, $\eta=.065$; alliteration awareness, $F(2, 70)=1.814$, $p=.171$, $\eta=.049$; or their vocabulary knowledge, $F(2, 70)=1.144$, $p=.324$, $\eta=.032$, illustrating that all groups improved at a similar rate on these skills.

When we look at improvements on each of the speech rhythm skills, we see that there were no significant differences between groups on their improvement in sensitivity to stress, $F(2, 70)=2.942$, $p=.059$, $\eta=.078$, nor timing, $F(2, 70)=.134$, $p=.875$, $\eta=.004$, but that there was a significant difference between groups on their change in intonation, $F(2, 70)=9.278$, $p<.001$, $\eta=.210$, which again remained after controlling for age, $F(2, 70)=9.460$, $p<.001$, $\eta=.218$. Tukey HSD post hoc analyses revealed that the speech rhythm group outperformed the phonological awareness group ($p=.001$) and the maths control group ($p=.001$) on their improvement in sensitivity to intonation, suggesting that training on the speech rhythm intervention can significantly improve sensitivity to intonation beyond any other method of tuition. This had a substantial effect on overall speech rhythm sensitivity, leading to a significant difference between groups on total speech rhythm sensitivity scores, $F(2, 70)=8.155$, $p=.001$, $\eta=.189$, which again remained after controlling for age, $F(2, 70)=7.983$, $p=.001$, $\eta=.188$, and individual differences in vocabulary, $F(2, 70)=7.897$, $p=.001$, $\eta=.188$. The Tukey HSD analysis showed that the speech rhythm group outperformed the phonological awareness group ($p=.011$) and the maths control group ($p=.001$) on their improvement in overall speech rhythm sensitivity.

5.3.3 Are These Improvements Maintained Over Time?

Table 5.6 shows the raw scores and mean changes in performance on all literacy assessments between the post-test (Time 2) in December 2012, and the delayed post-test (Time 3) in March 2013, for children in all three intervention groups.

Table 5.6 Mean changes between the post-test (Time 2) and the delayed post-test (Time 3) for all three intervention groups.

Variable	Group	Mean T2 score	SD	Mean T3 score	SD	Mean change T2:T3	SD
BAS Word	SR	9.42	5.22	16.35	7.62	6.92	3.53
Reading (/90)	PA	9.96	12.80	14.79	14.95	4.83	5.78
	Maths	11.00	17.06	16.20	17.42	5.20	3.97
Rhyme	SR	6.81	3.57	8.15	4.36	1.35	3.97
Detection (/21)	PA	5.33	4.01	5.08	3.13	-0.25	2.52
	Maths	7.75	5.95	8.50	6.37	0.75	3.27
Alliteration	SR	2.58	2.10	2.88	2.36	0.31	2.77
Detection (/10)	PA	2.96	2.63	2.71	3.07	-0.25	2.21
	Maths	2.70	3.16	3.35	3.60	0.65	1.73
Vocabulary	SR	70.69	12.49	74.31	10.99	3.62	6.95
	PA	69.58	13.63	72.21	16.06	2.63	8.14
	Maths	66.70	15.09	72.60	13.84	5.90	7.55
Speech Rhythm	SR	4.58	0.64	4.65	0.63	0.77	0.63
- Stress	PA	4.38	0.82	4.00	0.83	-0.38	1.01
Sensitivity (/5)	Maths	4.05	0.94	4.40	0.94	0.35	1.18
Speech Rhythm	SR	4.08	0.84	3.35	0.98	-0.73	1.15
- Intonation	PA	2.63	0.97	2.17	1.05	-0.46	1.50
Sensitivity (/5)	Maths	2.45	1.05	2.50	1.32	0.05	1.54
Speech Rhythm	SR	4.69	0.88	4.08	0.98	-0.62	1.13
– Timing	PA	4.67	0.76	3.83	1.20	-0.83	0.76
Sensitivity (/5)	Maths	4.15	0.93	3.80	1.40	-0.35	1.73
Speech Rhythm	SR	13.35	1.77	12.08	1.74	-1.27	1.85
Total (/15)	PA	11.67	1.71	10.00	2.25	-1.67	1.83
	Maths	10.65	1.84	10.70	2.15	0.05	2.70

Note: BAS = British Ability Scales, T2 = Time 2; T3 = Time 3; PA = Phonological Awareness, Vocabulary scores are BPVS raw scores.

As can be seen, the speech rhythm group showed the greatest continued improvement in word reading, but all three groups continued to improve on this measure, and on vocabulary scores. However, the speech rhythm group showed a decline in sensitivity to intonation and timing, and in overall speech rhythm sensitivity between Time 2 and Time 3, suggesting that continued training is needed to maintain these skills. Likewise, the PA group showed a decline in performance on all speech rhythm measures, as well as a decline in both rhyme awareness and alliteration awareness once their training had stopped. Furthermore, the PA group's decline in performance on the PA measures between Time 2 and Time 3 shows that they did not develop as rapidly as the speech rhythm group on these measures.

In order to determine whether there were significant differences between the three groups in their long term development, ANOVA was conducted on all 'maintenance' scores (changes in performance between Time 2 and Time 3). This revealed no significant difference between groups on their improvement in reading once the interventions were terminated, $F(2, 70)=1.505$, $p=.230$, $\eta=.043$. Additionally, there were no significant differences between groups on either their continued improvement in rhyme awareness, $F(2, 70)=1.450$, $p=.242$, $\eta=.041$, or alliteration awareness, $F(2, 70)=0.854$, $p=.430$, $\eta=.025$, and no significant difference between groups on their continued improvement in vocabulary knowledge, $F(2, 70)=1.063$, $p=.351$, $\eta=.031$. Similarly, there were no significant differences between groups on their improvement in intonation once the interventions were terminated, $F(2, 70)=1.794$, $p=.174$, $\eta=.051$, nor was there a significant different in improvement in timing at this stage, $F(2,70)=0.837$, $p=.438$, $\eta=.024$. There was, however, a significant difference between groups on their stress sensitivity after the intervention was withdrawn, $F(2, 70)=3.337$, $p=.042$, $\eta=.091$, which remained after controlling for age, $F(2, 70)=3.221$, $p=.046$, $\eta=.089$. A Tukey HSD analysis revealed that the maths group outperformed the PA group on their maintained stress sensitivity ($p=.036$). A similar pattern of results was found for overall speech rhythm sensitivity, where there was a significant difference between groups, $F(2, 70)=3.840$, $p=.026$, $\eta=.103$, which again remained after controlling for age, $F(2, 70)=3.755$, $p=.029$, $\eta=.102$. The Tukey HSD analysis again revealed that the maths group outperformed the PA group on their maintained speech rhythm sensitivity ($p=.025$) between Time 2 and Time 3. These results show that the degree of regression displayed by the Speech Rhythm intervention group were not significantly worse (or better) than that showed by the two control groups, and that the phonological awareness intervention group showed the greatest degree of regression in speech rhythm sensitivity. This may suggest that this type of training may somehow inhibit the growth of speech rhythm sensitivity over time. This point will be revisited in the discussion.

A final comparison was conducted to investigate the differences between the intervention groups between Time 1 and Time 3, in order to determine the overall long-term impact of the intervention. Table 5.7 shows the raw scores and mean changes in performance on all literacy assessments between the pre-test (Time 1) in September 2012, and the delayed post-test (Time 3) in March 2013, for children in all three intervention groups.

Table 5.7 Mean changes between the pre-test (Time 1) and the delayed post-test (Time 3) for all three intervention groups.

Variable	Group	Mean T1 score	SD	Mean T3 score	SD	Mean change T1:T3	SD
BAS Word Reading (/90)	SR	0.23	0.82	16.35	7.62	16.12	7.51
	PA	2.67	12.43	14.79	14.95	12.13	7.25
	Maths	5.55	16.17	16.20	17.42	10.65	5.37
Rhyme Detection (/21)	SR	5.50	3.87	8.15	4.36	2.65	4.03
	PA	4.38	4.07	5.08	3.13	0.71	4.30
	Maths	4.05	3.30	8.50	6.37	4.45	5.20
Alliteration Detection (/10)	SR	1.92	1.49	2.88	2.36	0.96	2.05
	PA	1.00	1.82	2.71	3.07	1.71	2.51
	Maths	2.00	2.97	3.35	3.60	1.35	2.30
Vocabulary	SR	62.31	11.84	74.31	10.99	12.00	6.42
	PA	62.88	18.21	72.21	16.06	9.33	7.21
	Maths	62.25	17.09	72.60	13.84	10.35	7.94
Speech Rhythm - Stress Sensitivity (/5)	SR	3.54	1.03	4.65	0.63	1.12	1.18
	PA	3.92	0.97	4.00	0.83	0.83	1.10
	Maths	3.85	0.99	4.40	0.94	0.55	1.19
Speech Rhythm - Intonation Sensitivity (/5)	SR	2.27	1.22	3.35	0.98	1.08	1.52
	PA	2.46	1.10	2.17	1.05	-0.29	1.55
	Maths	2.45	0.89	2.50	1.32	0.05	1.61
Speech Rhythm – Timing Sensitivity (/5)	SR	4.08	0.93	4.08	0.98	0.00	1.30
	PA	4.08	0.97	3.83	1.20	-0.25	1.19
	Maths	3.70	0.86	3.80	1.40	0.10	1.33
Speech Rhythm Total (/15)	SR	9.88	2.10	12.08	1.74	2.19	2.30
	PA	10.38	2.00	10.00	2.25	-0.38	2.45
	Maths	10.00	1.56	10.70	2.15	0.07	2.18

Note: BAS = British Ability Scales, T2 = Time 2; T3 = Time 3; PA = Phonological Awareness, Vocabulary scores are BPVS raw scores.

A final set of ANOVAs revealed that there was a significant difference between groups on their overall improvement in reading between Time 1 and Time 3, $F(2, 70)=4.005$, $p=.023$, $\eta=.107$, which remained after controlling for age, $F(2, 70)=5.320$, $p=.002$, $\eta=.195$, and for individual differences in vocabulary, $F(2, 70)=7.005$, $p=.000$, $\eta=.301$. A Tukey HSD analysis revealed that the speech rhythm group outperformed the maths control group in their overall gain in reading between Time 1 and Time 3 ($p=.025$), illustrating that the speech rhythm-based intervention is significantly better at improving word reading in the long term than a maths-based control intervention. There was also a significant difference between groups on their overall improvement in rhyme awareness between Time 1 and Time 3, $F(2, 70)=3.832$, $p=.027$, $\eta=.103$. This difference remained when controlling for individual differences in vocabulary, $F(2, 70)=3.282$, $p=.016$, $\eta=.168$, but did not remain when controlling for age, $F(2, 70)=2.662$, $p=.055$, $\eta=.108$. A Tukey HSD analysis revealed that the phonological awareness group improved significantly more than the maths-based control group between Time 1 and Time 3 on their rhyme awareness ($p=.020$), illustrating that the phonological awareness-based intervention was significantly better than the maths-based control intervention for improving rhyme awareness in the long term. ANOVA revealed no significant differences between groups on their overall improvement in alliteration between Time 1 and Time 3, $F(2, 70)=0.667$, $p=.517$, $\eta=.020$, and no significant difference between groups on their overall improvement in vocabulary knowledge, $F(2, 70)=0.888$, $p=.416$, $\eta=.026$. When we look at speech rhythm sensitivity, ANOVA revealed a significant difference between groups on their overall gains in sensitivity to stress, $F(2, 70)=5.005$, $p=.009$, $\eta=.135$, which remained after controlling for age, $F(2, 70)=3.539$, $p=.019$, $\eta=0.139$, and vocabulary, $F(2, 70)=2.653$, $p=.041$, $\eta=.140$. Tukey HSD illustrated that the speech rhythm group outperformed the phonological awareness group on their overall improvement in stress sensitivity ($p=.007$), suggesting that the speech rhythm intervention was significantly better than the phonological intervention for improving stress sensitivity in the long term. However, the speech rhythm group did not appear to be significantly better than the maths-based intervention for improving stress sensitivity in the long term ($p=.234$), which was surprising. Additionally, there was also a significant difference between groups on their overall improvement in intonation, $F(2, 70)=5.246$, $p=.008$, $\eta=.135$. This again remained after controlling for age, $F(2, 70)=3.616$, $p=.018$, $\eta=.141$, and vocabulary, $F(2, 70)=2.860$, $p=.030$, $\eta=.150$, and a Tukey HSD analysis revealed that, as with stress, the speech rhythm-based intervention was significantly better at improving sensitivity to intonation in the long term than the phonological awareness intervention ($p=.008$), but was not significantly better than the maths-based intervention ($p=.075$). There was no significant difference between groups on their overall improvement in sensitivity to timing, $F(2, 70)=0.455$, $p=.636$, $\eta=.013$, but the significant between group differences for stress and timing had an effect on the overall improvement in total speech rhythm sensitivity, in which there was a significant difference between groups, $F(2, 70)=7.747$, $p=.001$, $\eta=.188$, which remained after controlling for age, $F(2, 70)=5.245$, $p=.003$, $\eta=.193$, and vocabulary, $F(2, 70)=4.813$, $p=.002$, $\eta=.229$. A final Tukey HSD analysis revealed that children in the speech rhythm group had improved in their speech rhythm sensitivity significantly more between Time 1 and Time 3 than children in the phonological awareness group ($p=.001$), but not significantly more than children in the maths-based intervention group ($p=.085$), illustrating that the speech rhythm-based intervention was significantly better than the phonological awareness intervention at improving speech rhythm sensitivity in the long term, but was not significantly better than the maths-based control.

5.3.4 What are the Observable Characteristics of Children who benefit the most from the Speech Rhythm Based Intervention?

The children who displayed the greatest gains in their reading performance between Time 1 and Time 2 were isolated for further analyses as children who were deemed to have particularly benefitted from their allocated intervention approach. For this purpose, children who made gains of 10 words or more in their single word reading performance between Time 1 and Time 2 were selected. This was deemed appropriate because a gain of 10 words tends to indicate a rise of 6 months or more in reading age on the BAS II, which is greater than that which we would expect from natural maturation over the course of the 10 week intervention period. However, it should be noted that as these children were pre-readers, their post-test scores on the BAS reading assessment were still too low to calculate a reading age.

The characteristics of children who benefitted from exposure to the speech rhythm intervention (N=13) were compared to the characteristics of children who benefitted from exposure to the PA based intervention (N=6) to determine if literacy skills at Time 1 influenced response to different types of intervention. Table 5.8 illustrates the mean pre-test scores for children who benefitted and did not benefit from exposure to each of the three types of intervention.

Table 5.8 Mean pre-test scores for children who benefitted most from the speech rhythm intervention and children who benefitted from the PA intervention.

Variable	Group	Response Rate	Mean Pre-Test Score	SD
BAS Word Reading	SR	High	0.38	1.12
(/90)		Low	0.07	0.27
	PA	High	0.33	0.52
		Low	3.26	13.98
	Maths	High	15.33	24.01
		Low	3.61	14.33
Rhyme Awareness	SR	High	6.85	5.65
(/21)		Low	5.21	3.38
	PA	High	4.00	2.76
		Low	4.47	4.36
	Maths	High	5.67	0.58
		Low	3.89	3.44
Alliteration Awareness (/10)	SR	High	2.00	1.58
		Low	1.79	1.42
	PA	High	1.17	1.60
		Low	0.95	1.87
	Maths	High	3.33	3.21
		Low	1.78	2.88
Vocabulary	SR	High	64.85	12.86
		Low	60.14	10.30
	PA	High	65.83	14.62
		Low	60.74	19.64
	Maths	High	70.67	10.79
		Low	60.89	17.28
Speech Rhythm –	SR	High	3.69	1.32

Stress Sensitivity (/5)		Low	3.50	0.76
	PA	High	4.33	0.82
		Low	3.79	0.98
	Maths	High	4.33	0.58
		Low	3.78	1.00
Speech Rhythm – Intonation Sensitivity (/5)	SR	High	1.77	1.01
		Low	2.79	1.19
	PA	High	2.00	1.26
		Low	2.63	1.01
	Maths	High	2.33	0.58
		Low	2.44	0.92
Speech Rhythm – Timing Sensitivity (/5)	SR	High	4.46	0.78
		Low	3.79	0.97
	PA	High	4.50	0.55
		Low	3.89	1.05
	Maths	High	3.67	0.58
		Low	3.72	0.89
Speech Rhythm Sensitivity Total (/15)	SR	High	9.92	2.36
		Low	10.07	2.02
	PA	High	10.83	1.06
		Low	10.21	2.07
	Maths	High	10.33	1.53
		Low	9.94	1.55

Notes: SR = Speech Rhythm. PA= Phonological Awareness. High Response Rate = Gains of 10 words or more on the BAS reading assessment. Low Response Rate = Gains of less than 10 words on the BAS reading assessment.

Comparison of groups using ANOVA showed no significant differences between children who benefitted from the speech rhythm-based intervention and children who benefitted from the phonological awareness-based intervention on their baseline (Time 1) stress sensitivity, $F(1, 17)=1.190$, $p=.291$, $\eta=.065$; intonation sensitivity, $F(1, 17)=.183$, $p=.674$, $\eta=.011$; timing sensitivity, $F(1, 17)=.012$, $p=.915$, $\eta=.001$; total speech rhythm sensitivity, $F(1, 17)=.725$, $p=.406$, $\eta=.041$; word reading, $F(1, 17)=.011$, $p=.917$, $\eta=.001$; rhyme awareness, $F(1, 17)=1.341$, $p=.263$, $\eta=.073$; alliteration awareness, $F(1, 17)=1.131$, $p=.302$, $\eta=.062$, or vocabulary, $F(1, 17)=.022$, $p=.883$, $\eta=.001$. An additional ANOVA showed no significant differences at the pre-test between children who benefitted from exposure to the speech rhythm intervention compared to children who did not benefit from exposure to the speech rhythm intervention in terms of their stress sensitivity, $F(1, 25)=.220$, $p=.643$, $\eta=.009$; timing sensitivity, $F(1, 25)=3.929$, $p=.059$, $\eta=.136$; total speech rhythm sensitivity, $F(1, 25)=.031$, $p=.862$, $\eta=.001$; word reading, $F(1, 25)=1.033$, $p=.319$, $\eta=.040$; rhyme awareness, $F(1, 25)= .843$, $p=.361$, $\eta=.033$; alliteration awareness, $F(1, 25)=.137$, $p=.714$, $\eta=.005$, or vocabulary, $F(1, 25)=1.108$, $p=.303$, $\eta=.042$. However, children who benefited from exposure to the speech rhythm based intervention appeared to have significantly lower sensitivity to intonation at Time 1 than children who benefitted from exposure to the phonological awareness-based intervention, $F(1, 25)=5.678$, $p=.025$, $\eta=.185$. Final ANOVA determined that there were no significant differences at the pre-test between children who did benefit and children who did not benefit from exposure to the phonological awareness intervention in terms of stress sensitivity, $F(1, 23)=1.514$, $p=.231$, $\eta=.062$; intonation sensitivity, $F(1, 23)=1.583$, $p=.221$, $\eta=.064$; timing sensitivity, $F(1, 23)=1.805$, $p=.192$, $\eta=.073$; total speech rhythm sensitivity, $F(1, 23)=.452$, $p=.508$, $\eta=.019$; word reading, $F(1, 23)=.256$,

$p=.618$, $\eta=.011$; rhyme awareness, $F(1, 23)=.062$, $p=.806$, $\eta=.003$; alliteration awareness, $F(1, 23)=.067$, $p=.799$, $\eta=.003$ or vocabulary, $F(1, 23)=.340$, $p=.565$, $\eta=.015$.

Furthermore, there were no significant differences between children whose reading did benefit and children whose reading did not benefit from exposure to the maths-based control intervention in their stress sensitivity, $F(1, 21)=1.165$, $p=.293$, $\eta=.053$; intonation sensitivity, $F(1, 21)=.181$, $p=.674$, $\eta=.009$; timing sensitivity, $F(1, 21)=.023$, $p=.880$, $\eta=.001$; total speech rhythm sensitivity, $F(1, 21)=.079$, $p=.781$, $\eta=.004$; word reading, $F(1, 21)=1.713$, $p=.205$, $\eta=.075$; rhyme awareness, $F(1, 21)=.439$, $p=.515$, $\eta=.020$; alliteration awareness, $F(1, 21)=.846$, $p=.368$, $\eta=.039$, or vocabulary, $F(1, 21)=.874$, $p=.360$, $\eta=.040$.

5.3.5 Week-by-Week Learning Profiles

Each week notes were kept of how well the children were performing on the formative tasks which the three different interventions were based on. These data were examined to see the extent to which the children were responding to the treatments during the delivery of the intervention itself. This week-by-week data showed that children exposed to the speech rhythm-based intervention showed a steady improvement in speech rhythm performance across the intervention period (see Figure 5.1). However, this pattern of improvement on trained items was not apparent for children exposed to the other two interventions. Possible explanations for this pattern of results are explored in the discussion.

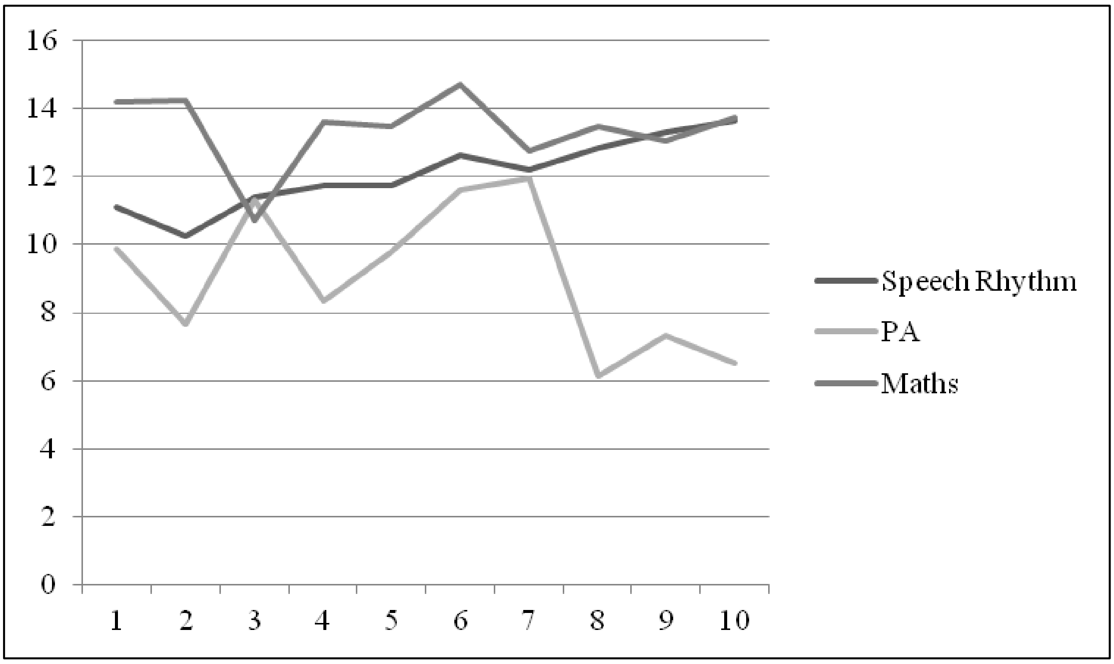

Figure 5.1: Line graph illustrating week by week improvements for each intervention group.

5.4 Discussion

This study set out to examine the immediate and longer term effectiveness of a speech rhythm-based intervention in a group of beginning readers, aiming to discover (a) whether a set of activities which aimed to improve children's sensitivity to speech rhythm could benefit their reading development, (b) whether these activities could result in gains that were equivalent to those observed by a more traditional phonological-based intervention, and (c) whether the observable characteristics of children who benefitted from the speech rhythm-based intervention differed from those of children who benefitted from phonologically-based interventions.

It was found that training on the speech rhythm-based intervention resulted in significant gains in speech rhythm sensitivity at the post-test which were above and beyond those experienced by children in either the phonological awareness group or the maths-based control group. This was expected as the training specifically taught children in the speech rhythm group about the aspects of speech rhythm which were later assessed. However, when we broke speech rhythm down into the individual components of stress, intonation and timing, we saw no significant differences between groups on their improvement in sensitivity to stress or timing, but that there was a significantly greater degree of improvement in sensitivity to intonation in the speech rhythm group than the other two intervention groups. It appears that children may require more training to become sensitive to intonation than they require to become sensitive to stress and timing. This relates to the idea of speech rhythm being a unitary construct. A lot of research has focused on sensitivity to stress (e.g. Wood, 2006; Wood and Terrell, 1998), and assumed performance on tasks assessing this skill to be a proxy for of an overall measure of speech prosody. However, the different levels of performance in the three aspects of speech rhythm sensitivity assessed in this study, and the different levels of response to training that have been observed, suggests that sensitivity to stress is not necessarily representative of speech rhythm as a whole. In addition, whilst the correlation matrices displayed in tables 5.1, 5.2, 5.3 and 5.4 illustrate that sensitivity to each of the individual components of speech rhythm was correlated with overall speech rhythm sensitivity, these correlation matrices also illustrate that the individual components of speech rhythm sensitivity were not significantly correlated with one another either at the pre-test or the post-test for any of the intervention groups, further supporting the idea that speech rhythm is not a unitary construct. Furthermore, correlation matrices revealed that speech rhythm sensitivity was related to reading performance at the baseline (pre-test) for all children, and that the individual components of stress and timing were also individually correlated with single word reading performance, but intonation was not, suggesting that the three components may play different roles in the relationship between overall speech rhythm sensitivity and reading. The post-test correlation matrices indicate that although sensitivity to stress and timing were correlated with reading performance at the pre-test, these skills were not correlated with reading at the post-test, suggesting that the relationship between speech rhythm skills and reading changes over time and further supporting the idea that each component of speech rhythm has a different relationship with reading skills.

This idea is supported by looking at the raw scores presented in Table 5.5, where we can observe that children generally had greater sensitivity to stress and timing at the baseline (Time 1) than they did to intonation at this time. This could have influenced the degree of improvement observed between pre- and post-test, as there was more room for improvement in intonation, and indeed, this was the skill that the speech rhythm group showed the greatest improvement on out of the three speech rhythm measures. The varied sensitivity to each of the three elements of speech rhythm at baseline once again relates back to the question of whether speech rhythm can be labeled as a unitary construct. Indeed, as discussed in section 2.1, the different components of speech rhythm have been shown to be related to reading skills in a number of different ways. For example, whilst Holliman, Wood and Sheehy (2008) showed that stress sensitivity is related to phonemic and rhyme awareness, and Wood (2006) additionally showed that stress sensitivity is related to spelling ability, Schwanenflugel et al (2004) illustrated that sensitivity to intonation is related to decoding ability, and Miller and Schwanenflugel (2008) also found a relationship between sensitivity to intonation and reading fluency. Holliman et al (2013) summarised this evidence, claiming that research is moving towards an understanding of the individual components of prosody, and acknowledged that the individual components may play different roles in the relationship between speech rhythm sensitivity and reading.

Perhaps the most interesting finding was that training on the speech rhythm-based intervention resulted in significant gains in word reading performance, and that these gains were more profound in children receiving the speech rhythm intervention than in children receiving the control condition. These findings supported the hypothesis that training on the speech rhythm-based intervention could result in higher gains in reading performance than training on a control intervention. However, the lack of a significant difference in progress between the children receiving the phonological awareness (PA) and maths-based interventions was surprising. It appeared that training on the PA-based intervention did not impact reading as expected, and further to this, results showed no significant differences between any of the groups on their improvement on either of the phonological awareness measures between Time 1 and Time 2, thus also suggesting that the PA-based intervention was not as effective as we would expect for improving phonological awareness. It was perhaps ambitious to predict that the speech rhythm-based intervention would improve equally on their phonological awareness to children who were specifically trained on PA. However, these results do support the hypothesis by showing that there was in fact no significant difference between any of the groups on their improvement in these skills, and the reasons for this are uncertain. It is possible that ten weeks may not have been long enough for the PA intervention to have had a significant effect, especially given that the children in this study only received 300 minutes of training in PA in total, including both the directed tuition and carpet time activities. Nevertheless, Hatcher, Hulme, Miles, Carroll, Hatcher, Gibbs, Smith, Bowyer-Crane and Snowling (2006) have demonstrated that ten weeks is sufficient for significant changes to occur. Alternatively, the wide variety of activities and skills covered using the Sound Linkage intervention activities could have meant that the children did not receive sufficient training on the specific aspects of phonological awareness that were actually assessed. If PA training had focused primarily on just rhyme awareness and alliteration, then we might expect to see much more of an improvement in these skills. Furthermore, when we considered week-by-week data for children in the PA group, our results showed that performance on these tasks did not improve steadily over the intervention period. It may also be the case that some of the tasks were too difficult for the reception children to understand, resulting in a low performance rate for those weeks. The data illustrated in Figure 1 support this suggestion, showing a fall in performance on specific weeks. Whilst there is no evidence to suggest that the PA intervention used here would be effective in such young children, participants of this age range are seldom studied in reading intervention research because they have not yet begun formal reading instruction. The study by Hatcher et al (2006) found the intervention to be successful in participants in Year 1 (aged 5-6 years), and although there would be some overlap in ability between children in reception and Year 1 classes, it seems reasonable to suggest that for some children the activities would be too advanced. However, it should equally be noted that in Table 5.5 there was evidence that the children in the PA group were of higher reading ability than the children in the speech rhythm group at Time 1. In relation to the theory set out in section 2.2, if sensitivity to speech rhythm is required for successful acquisition of phonological awareness, it is possible that children receiving the PA intervention may not have had adequate speech rhythm sensitivity to respond to the PA training. However, it should also be noted that children in the PA group had higher reading performance at Time 1 than children in the speech rhythm group. In relation to the theory, if speech rhythm sensitivity is needed for successful acquisition of segmental phonological awareness, we would also expect these children to have higher speech rhythm sensitivity at the given time. From looking at the pre-test scores in Table 5.5, we can see that this is the case, therefore supporting the theory.

When we consider the delayed post-test data, we can observe a marked decline in performance between Time 2 and Time 3 on the speech rhythm measures for children who received the speech rhythm-based intervention, illustrating that improvement was not maintained over time. It is suggested that children need continued training to maintain their speech rhythm sensitivity, and that once the intervention is terminated, performance will fall because they are no longer practicing these skills within the classroom. It is suggested that with continued training, children's level of speech rhythm sensitivity would be maintained. When we look at the PA group in particular, we can observe that children who received training on the phonological awareness-based intervention also showed a decline in speech rhythm sensitivity at the delayed post-test. Furthermore, when we look at the overall change in performance between Time 1 and Time 3 on all literacy skills for children in all three groups (see Table 5.7), we observe that children in the PA group continued to decline in their performance on the speech rhythm sensitivity measures, suggesting that the PA intervention may somehow suppress sensitivity to speech rhythm. We can relate this to the theory set out in section 2.2, where it was proposed that children need awareness of suprasegmental phonology (speech rhythm) in order to successfully acquire segmental phonological awareness. If this is the case, it is possible that training on PA inhibits the growth of speech rhythm sensitivity because speech rhythm is a higher level skill, suggesting that if speech rhythm sensitivity is not already developed at the time children become exposed to PA-based reading tuition, speech rhythm will not continue to develop. This indicates that speech rhythm sensitivity is a skill that will go through a period of decline during the school years if training is not altered to incorporate specific training on these skills.

Interestingly, the PA group also showed a decline in performance on the phonological awareness measures between Time 2 and Time 3, again perhaps due to a lack of training once the intervention had been terminated. However, what is most interesting is that the speech rhythm group continued to improve on the phonological awareness measures between Time 2 and Time 3. In relation to the theory, it is possible that early training on speech rhythm sensitivity enables phonological awareness to develop more naturally, regardless of training.

Further analysis of the delayed post-test data revealed that there were no significant differences between groups on their reading improvement between Time 2 and Time 3, suggesting that once training is terminated, all groups go back to “normal” in terms of their improvement rate. Similarly, improvement rates do the same for all other skills, showing no differences between any of the groups on their improvement on any of the skills between the end of the intervention period and the delayed post-test. The only exception is stress awareness, which continued to develop at a greater rate for children in the maths group than children in the phonological awareness group. This is interesting, as there was no significant difference between the speech rhythm group and either the PA group or the maths group at this stage. However, the fact that the maths group showed a greater improvement in stress sensitivity than the PA group suggests again that PA training may somehow inhibit the growth of stress sensitivity. To support this further, inspection of the overall improvement data looking at improvements in all skills between Time 1 and Time 3 illustrated that the speech rhythm intervention improved on sensitivity to stress, sensitivity to intonation, and overall speech rhythm sensitivity significantly more than the PA intervention, but not more than the maths-based control intervention. This suggests that speech rhythm sensitivity may develop naturally (as in the maths-based control) at an equal rate to that achieved by training on a speech rhythm-based intervention in the long term, and that training on a PA-based intervention may prevent speech rhythm sensitivity from developing to this same rate.

Finally, in relation to the hypotheses set out at the beginning of this thesis and in relation to this first study, we must consider the characteristics of children whose reading performance benefitted the most from exposure to each type of intervention. Results indicated that there were no differences between children who benefitted from the speech rhythm intervention and children who benefitted from the PA intervention at the pre-test, suggesting that there are no characteristic differences which may pre-determine a child's response to a specific type of intervention in this age group. However, when we looked at the differences between the children who benefitted from the speech rhythm intervention and children who did not, we observed that children who had lower sensitivity to intonation at the pre-test responded better to the speech rhythm intervention than those with better pre-test sensitivity to intonation. This suggests that children with low sensitivity to intonation may respond better to speech rhythm-based training than children with good intonation, although it should be acknowledged that intonation was the skill with the lowest mean score at Time 1 out of all of the speech rhythm measures, and so this had the greatest room for improvement, which could have skewed the results and led to this finding.

5.4.1 Limitations and Future Directions

A weakness of this study lies in the fact that whilst participants were randomly allocated to intervention groups, it seemed that the small number (N=3) of high-performing children were placed either in the PA group or the maths-based control group. As these children were already performing at near ceiling level on most of the tasks, there was little room for improvement when it came to the post-test assessments. However, when we removed these children (N=3) and re-ran the analysis, results remained the same. It seems then, that the PA intervention as delivered here simply was not effective at training children on their phonological awareness during this short intervention period. It is therefore important that future research comparing the impacts of various interventions considers the content of PA interventions in relation to assessments of phonological awareness.

5.5 Conclusions

Overall, the results of this study suggest that the speech rhythm-based intervention was successful in improving speech rhythm sensitivity, and also at improving word reading performance in a group of children in the early stages of reading acquisition. Furthermore, results have indicated that training on a PA-based intervention may suppress the development of speech rhythm sensitivity over time, suggesting that training methods should be adapted to include speech rhythm sensitivity. The young age range selected for participation in this study enabled comparison of intervention approaches in beginning readers, which adds to the expanding literature on speech rhythm and reading, and is something that has not previously been explored in relation to intervention research. It is concluded that training on the speech rhythm-based intervention can improve both speech rhythm sensitivity and word reading ability of beginning readers at a level beyond that of a non-reading control intervention, but we are cautious with respect to our interpretation of the results comparing speech rhythm to PA-based training methods and further research is therefore warranted.

Chapter 6: Study 2

A Randomised Controlled Trial of the Immediate and Longer Term Effectiveness of the Speech Rhythm-Based Intervention in 7-8 year-old Struggling Readers

6.1 Introduction

As discussed in Chapters 1 and 2, there are two types of phonology which children need to be aware of in order to develop successful reading skills. Segmental phonology is concerned with the separable sound segments of spoken language such as phonemes, syllables, onset, codas and rimes. Much research has demonstrated that segmental phonological awareness is implicated in processes of successful reading development (e.g. Melby-Lervag, Lyster and Hulme, 2012). However, there is a second type of phonology which has often been overlooked in literacy research in the past. It is now proposed that successful reading acquisition requires not only awareness of segmental phonology but also awareness of suprasegmental phonology (e.g. Goswami, Thomson, Richardson, Stainthorp, Hughes, and Rosen et al, 2002; Holliman, Wood and Sheehy, 2008; Holliman et al, 2010a, 2010b; Schwanenflugel et al, 2004; Whalley and Hansen, 2006). The theory set out in section 2.2 suggests that children require awareness of suprasemental phonology in order to successfully acquire segmental phonological awareness and subsequently develop reading skills. Indeed, awareness of suprasegmental phonology, or speech rhythm as it is otherwise known, has been shown to be related to various aspects of reading development, and also reading difficulties (see Chapter 2).

This link between sensitivity to speech rhythm and reading difficulties has promoted the development of interventions focusing on training rhythmic skills. One of the first rhythmic-based training programmes was developed by Samuelsson (2011), who trained a boy aged 4.5 years on prosodic elements of language through six 60-minute sessions. Samuelsson found that the participant improved on measures of prosodic sensitivity at the word, phrase and discourse level and also showed increased use speech of prosody, supporting the use of a rhythmic-based intervention for improving prosodic sensitivity. However, Samuelsson did not include measures of literacy in her study, and so the impact of the intervention on literacy skills cannot be determined. Thomson, Leong and Goswami (2013) further demonstrated the potential of prosodic training by comparing a rhythmic-based training programme to a phonetic intervention and an untreated control group. Thirty-three dyslexic children took part, with a mean age of 9 years, 4 months. The rhythmic intervention comprised various tasks, including speech and non-speech rhythm tasks, drumming exercises and computer activities, and was administered in 30 minute sessions once weekly over 6 weeks. Results showed that the rhythmic-based intervention resulted in equivalent gains to the phonetic training programme in various literacy abilities including spelling, word- and non-word reading, phonological awareness and rise-time discrimination, indicating that both types of intervention are equally beneficial to reading skills. However, this study can be criticised for its small sample size and for only focusing on children with dyslexia. In addition, the study did not include a delayed post-test, and so the long-term effects of the intervention are uncertain. In a similar study, Bhide, Power and Goswami (2013) administered a rhythmic-based intervention in comparison to a letter-based phonological intervention in a sample of nineteen 6-7 year-old poor readers. As with the intervention employed by Thomson et al, the rhythmic intervention in this study comprised numerous tasks including tapping exercises, same-different judgment tasks on tempo and rhythm, rise-time discrimination and clapping to a beat. The interventions were administered over 2 months, including nineteen 25-minute sessions. Results showed that training on the rhythmic-based intervention benefitted both reading and phonological awareness, but that there were no significant differences between the rhythmic group and the phonological group on their improvement in these skills. Although this study provides similar results to the study by Thomson et al, Bhide et al did not include an untreated control group in their study, and so it is difficult to determine the effectiveness of the intervention and whether improvements were due to training or maturation over time. In addition, the poor readers selected for participation were nominated by their class teachers as having lower reading abilities than their peers, with no standardised screening assessment being used to select participants. Additionally, as with the study by Thomson et al, this study did not include a delayed post-test, so the long term effects of a rhythmic based intervention remain undetermined. Furthermore, whilst both of these studies trained both speech and non-speech rhythm, the rhythmic training focused on speech rhythm as a whole unit and did not break it down into its individual components. As recent research has suggested that speech rhythm may not be aunitary construct, it may be important to focus on the individual contribution of these elements to reading skills, and to date this remains unknown.

Such research has led to the development of the intervention outlined in Chapter 3. This new type of speech rhythm-based reading intervention aimed to train children’s awareness of speech rhythm sensitivity as a possible way of enhancing their reading performance. The process of training children on three individual rhythmic components (namely stress, intonation and timing) allows us to see the individual contributions of each element of speech rhythm, which has not been investigated in rhythmic intervention research to date. The intervention was administered once weekly over a 10-week period, during which the children were trained in small groups of three together with the administrator. Study 1 administered this intervention in comparison with a traditional phonological-based intervention and a maths-based control intervention in seventy-three 4-5 year old beginning readers. Assessments of various literacy skills were administered at the pre-test and post-test, and the study also included a delayed post-test to determine any longer-lasting effects and add to existing research in this field which had not previously included a delayed post-test. Study 1 found that training 4-5 year-old beginning readers on a speech rhythm-based reading intervention could improve their speech rhythm sensitivity and single word reading at a level beyond that of a control (maths-based) intervention. However, when training was terminated, a decline in speech rhythm sensitivity was observed, suggesting that continued training is necessary to maintain sensitivity to speech rhythm over time. Study 1 also found evidence to support the notion that speech rhythm is not a unitary construct, showing that the different components of speech rhythm appear to be related to reading in different ways. Further findings suggested that training on a phonological awareness-based intervention appeared to suppress speech rhythm sensitivity, although we must be cautious in comparing the speech rhythm intervention with the PA-based intervention because of the lack of improvement in phonological awareness as a result of PA training.

Currently, as the speech rhythm intervention implemented in this thesis has only recently been developed and has therefore only been researched in relation to beginning readers, there remains the question over whether such training methods may be effective in raising the achievement levels of children who have already received some formal reading tuition, but who may be struggling to grasp the concepts necessary for multisyllabic word reading. Although both Thomson et al (2013) and Bhide et al (2013) have investigated the ability of rhythmic-based training to improve the literacy skills of poor readers, their studies did not include a delayed post-test assessment to determine the longer-lasting effects of the intervention. In addition, the poor readers recruited for use in Bhide et al's study were selected on the basis of teacher nomination and were not selected through standardised screening assessments.

In this second study, we therefore aimed to determine whether training on a speech rhythm-based reading intervention could enhance the word reading ability of a group of 7-8 year-old children who had already been shown to perform at a level below that which we would expect for a child in their age group on a standardised reading test. Through this we aimed to answer the following questions:

1. Can training on a speech rhythm based reading intervention enhance the word reading abilities of children ages 7-8 years who perform below the expected level on a standardised reading test?
2. Can training on the speech rhythm-based intervention result in gains in literacy skills that are at least equivalent to training on a more traditional, phonological-awareness-based intervention?

3. Do children who benefit from exposure to the speech rhythm-based intervention differ in their characteristics from children who benefit from exposure to a more traditional phonological approach to reading tuition?

It was predicted that training on the speech rhythm-based intervention would result in gains in speech rhythm sensitivity and reading performance that are at least equivalent to the gains observed in children exposed to a traditional phonological awareness-based intervention. It was also predicted that training on the speech rhythm-based intervention would result in gains in literacy skills that are significantly greater than those made by children exposed to a control (semantic-based) intervention.

6.2 Method

6.2.1 Participants

All Year 3 children at participating schools were screened on their single word reading ability to enable us to determine those who were falling below the expected level for a child in their age group. All children who performed at more than 6 months below their chronological age were selected for participation. Parental information letters and opt-out consent forms were sent out to the parents/ guardians of these children via the schools. An opt-out procedure was used to maximise participation and also because it was assumed that parents would want their child to take part in something that would benefit their academic performance. Parents were given 2 weeks to send the opt-out form back to the school if they wished to opt out of the study. From this procedure, forty-nine children (25 females, 24 males), with a mean age of 7 years 11 months at Time 1, were recruited from year 3 classes at three primary schools in Coventry, West Midlands. All participating children were assessed on pre-test measures of various literacy skills (see below), and were then randomly allocated to an intervention group, receiving either the speech rhythm based intervention (n=20), a traditional phonological awareness based intervention (n=15), or a control (semantic-based) intervention (n=14).

6.2.2 Materials

The following assessments were used in this study:

- The Diagnostic Test of Word Reading Processes
- The York Assessment of Reading Comprehension
- The Rhyme, Alliteration and Spoonerism Subtests of the Phonological Assessment Battery
- The Speech Rhythm Sensitivity Assessment (using different items to those administered in the intervention)
- The Weschler Abbreviated Scale of Intelligence

In addition to these assessments, the following intervention materials were administered over a 10 week period:

- The Speech Rhythm-Based Intervention
- The Jolly Phonics Intervention
- The Semantic Control Intervention

6.2.3 Procedure

This study comprised two cohorts of children due to low participant numbers in the first round of recruitment. It should be noted that there were no significant differences between the two samples at the pre-test and data were therefore combined to form a larger single data set. Firstly, all Year 3 children at participating schools were screened for their single word reading ability to determine those who were falling below the level expected for a child in their age group. This took place in April 2013 for cohort 1, and September 2013 for cohort 2. Children who displayed a reading age of more than 6 months below their chronological age were selected as potential participants. This 6 month cut-off point was selected to incorporate as many of the children that had been screened as possible, but was also informed by informal teacher ratings as some of the children who they deemed to be struggling and who they would like to be involved in the project were performing at around 6 months below their chronological age. Participant information sheets and opt-out consent forms were sent out via the schools to the parents of these children, and parents were given 2 weeks to send these letters back, after which it was assumed that they consented for their child to take part. All participating children completed pre-test assessments of their single word reading ability, reading comprehension, phonological awareness, general intelligence and speech rhythm sensitivity (Time 1). They were then randomly allocated to receive either the new speech rhythm-based intervention, a traditional phonological awareness based intervention or a control (semantic-based) intervention, administered in once-weekly 15-minute sessions over a 10-week period. For cohort 1 this was between April-June 2013, and for cohort 2 this was between September-December 2013. It should be noted that children in Study 2 did not receive the additional ‘carpet-time’ activities as in Study 1, as due to small participant numbers in each cohort it was impractical to get all of the children in each intervention group together on a regular basis. Immediately following the intervention phase, all participating children completed post-test assessments of their single word reading ability, reading comprehension, phonological awareness, general intelligence and speech rhythm sensitivity (Time 2), in June 2013 for cohort 1, and December 2013 for cohort 2. These assessments were completed again three months later in a delayed post test (Time 3), in September 2013 for cohort 1, and March 2014 for cohort 2, with each assessment session lasting approximately 20 minutes.

6.3 Results

6.3.1 Correlations

As in study 1, it was important to determine how well each of the speech rhythm variables correlated with the various literacy measures before training. A correlation analysis was conducted on all pre-test data for this purpose, and is presented in Table 6.1.

It can be observed that at the baseline (pre-test) each of the individual measures of speech rhythm sensitivity were correlated with overall speech rhythm sensitivity as expected, however none of the speech rhythm measures were significantly correlated with each other, nor were they correlated with reading or any other literacy skill. The correlation matrix also reveals that the three measures of phonological awareness (rhyme awareness, alliteration awareness and spoonerism awareness) were all significantly correlated with each other, and each of these was significantly correlated with single word reading performance. Additionally, accuracy on the York

Assessment of Reading Comprehension was significantly correlated with single word reading as would be expected. Accuracy on the YARC also correlated with all PA measures. Similarly, reading comprehension was correlated with both reading and all PA measures, and all of the YARC measures were correlated with each other. Performance on the block building task was correlated with all PA measures and reading comprehension. Vocabulary was correlated with word reading, rhyme awareness and spoonerism awareness, but was not significantly correlated with alliteration awareness. Vocabulary was also correlated with accuracy and comprehension on the YARC. Matrix reasoning was correlated with reading, alliteration awareness and spoonerism awareness but was not correlated with rhyme awareness. Matrix reasoning was also correlated with reading accuracy and comprehension, and with block building and vocabulary. Finally, performance on the similarities task was correlated with reading, all PA measures, reading, rate and comprehension on the YARC, block building and matrix reasoning, but not vocabulary.

Additional correlation analyses were conducted on the post-test data for each group to determine whether this pattern of correlations had altered as a result of training. The correlation analyses for each of the three groups at post-test are presented in tables 6.2, 6.3, and 6.4.

Table 6.2 shows that for children who received the speech rhythm-based intervention, intonation sensitivity was significantly correlated with total speech rhythm sensitivity, spoonerism awareness, reading comprehension, block building and vocabulary at the post-test. Total speech rhythm sensitivity was also significantly correlated with spoonerism awareness, reading comprehension, block building and vocabulary. However, as with the pre-test, speech rhythm sensitivity was not correlated with reading performance at Time 2. Unlike the results at pre-test, none of the PA measures were significantly correlated with each other at the post-test for children who received the speech rhythm intervention, but both alliteration awareness and spoonerism awareness were both correlated with reading comprehension. Word reading was correlated with rhyme awareness, spoonerism awareness, reading accuracy on the YARC, reading rate, reading comprehension and the WASI similarities assessment. Vocabulary was additionally correlated with spoonerism awareness and matrix reasoning, and matrix reasoning was additionally correlated with alliteration and block building.

Correlations at the post-test were also explored for children who received the phonological awareness-based intervention, presented in Table 6.3. It can be observed that for children who received training on the PA based intervention, total speech rhythm sensitivity was correlated with reading accuracy as measured by the YARC but was not correlated with word reading on the DTWRP at the post-test. Additionally, speech rhythm sensitivity was correlated with reading comprehension, vocabulary and matrix reasoning. As in the pre-test, none of the speech rhythm measures were significantly correlated with each other, but sensitivity to stress and intonation were both correlated with total speech rhythm sensitivity. Sensitivity to intonation was also correlated with reading comprehension, vocabulary and matrix reasoning. Word reading on the DTWRP was correlated with word reading accuracy on the YARC as would be expected, and was also significantly correlated with rhyme awareness, reading rate, reading comprehension, vocabulary and matrix reasoning. Rhyme awareness was also significantly correlated with spoonerism awareness but was neither of these measures of PA were significantly correlated with alliteration awareness. Rhyme awareness was also correlated with reading accuracy, reading rate and reading comprehension on the YARC, and reading accuracy and rate were also correlated with each other and with reading comprehension. Block building was correlated with alliteration, spoonerisms and reading comprehension. Vocabulary was correlated with reading accuracy, rate and comprehension on the YARC and matrix reasoning. Finally, matrix reasoning was correlated with reading accuracy, rate and comprehension.

Finally, correlations were also explored for the post-test data for children who received the semantic-based control intervention. This is presented in Table 6.4, where we can observe that both sensitivity to stress and intonation are correlated with overall speech rhythm sensitivity but that none of the individual components of speech rhythm are correlated with each other, nor with any other measure that was assessed. Similarly, total speech rhythm sensitivity was not correlated with any other variable. All three measures of phonological awareness (rhyme awareness, alliteration awareness and spoonerism awareness) were all significantly correlated with each other, and rhyme awareness additionally correlated with reading comprehension, whilst alliteration and spoonerism awareness both correlated with the similarities assessment on the WASI. Furthermore, reading performance on the DTWRP was correlated with reading accuracy on the YARC as expected. Finally, block building was correlated with matrix reasoning.

Table 6.1 Correlation matrix between the speech rhythm variables and outcome variables at Time 1 for all children

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Stress	1.000														
2. Intonation	.102	1.000													
3. Timing	-.007	.029	1.000												
4. Total Speech Rhythm	.673***	.632***	.459***	1.000											
5. DTWRP Reading	.125	.047	.080	.149	1.000										
6. PhAB Rhyme	.120	-.024	.104	.099	.578***	1.000									
7. PhAB Alliteration	.142	-.091	.218	.157	.439**	.507***	1.000								
8. PhAB Spoonerism	.119	.186	.077	.242	.427**	.386**	.513***	1.000							
9. YARC .Accuracy	.245	.036	-.104	.121	.690***	.412**	.329*	.392**	1.000						
10. YARC Rate	.239	.111	-.262	.084	.559***	.028	.195	.339	.746**	1.000					
11. YARC Comprehension	.234	-.046	.041	.158	.506***	.545***	.486***	.485***	.649***	.413*	1.000				
12. WASI Block Building	.041	-.064	-.023	.013	.241	.321*	.405**	.421**	.226	.112	.527***	1.000			
13. WASI Vocabulary	.209	.150	.040	.248	.416**	.368**	.279	.373**	.433**	.187	.412**	.075	1.000		
14. WASI Matrix Reasoning	.124	-.093	-.032	.044	.284*	.276	.370**	.440**	.436**	.271	.527***	.449***	.347*	1.000	
15. WASI Similarities	.131	-.087	.057	.049	.486***	.430**	.444***	.490***	.549***	.456**	.500***	.444***	.229	.444***	1.000

Notes: *p<.05, **p<.01, ***p<.001
DTWRP = Diagnostic Test of Word Reading Processes; PhAB = Phonological Assessment Battery, WASI = Weschler Abbreviated Scale of Intelligence

Table 6.2 Correlation matrix between the speech rhythm variables and outcome variables at Time 2 for children receiving the speech rhythm-based intervention

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Stress															
2. Intonation		1.000													
3. Timing															
4. Total Speech Rhythm		1.000***		1.000											
5. DTWRP Reading		-.014		-.014	1.000										
6. PhAB Rhyme		-.144		-.144	.498*	1.000									
7. PhAB Alliteration		.190		.190	.414	.407	1.000								
8. PhAB Spoonerism		.494*		.494*	.497*	.434	.321	1.000							
9. YARC .Accuracy		-.341		-.341	.793***	.334	.118	.273	1.000						
10. YARC Rate		-.261		-.261	.696**	.310	.192	.363	.788***	1.000					
11. YARC Comprehension		.531*		.531*	.622**	.186	.688**	.687**	.352	.439	1.000				
12. WASI Block Building		.581*		.581*	.048	.150	.089	.294	-.108	-.095	.218	1.000			
13. WASI Vocabulary		.614**		.614**	.171	.078	.255	.751***	.001	.075	.586*	.462	1.000		
14. WASI Matrix Reasoning		.414		.414	.068	.113	.528*	.237	-.235	-.168	.372	.513*	.554*	1.000	
15. WASI Similarities		.376		.376	-.543*	-.180	-.129	-.274	-.671**	-.747**	-.308	.214	-.099	.290	1.000

Notes: *p<.05, **p<.01, ***p<.001
DTWRP = Diagnostic Test of Word Reading Processes; PhAB = Phonological Assessment Battery, WASI = Weschler Abbreviated Scale of Intelligence

Table 6.3 Correlation matrix between the speech rhythm variables and outcome variables at Time 2 for children receiving the phonological awareness-based intervention

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Stress	1.000														
2. Intonation	.257	1.000													
3. Timing	.085	-.157	1.000												
4. Total Speech Rhythm	.566*	.832***	.303	1.000											
5. DTWRP Reading	.295	.463	.065	.460	1.000										
6. PhAB Rhyme	.284	.453	-.263	.345	.631*	1.000									
7. PhAB Alliteration	.273	.444	-.055	.441	.072	.278	1.000								
8. PhAB Spoonerism	.216	.423	-.202	.338	.416	.819***	.476	1.000							
9. YARC .Accuracy	.296	.409	.241	.553*	.747**	.566*	.003	.396	1.000						
10. YARC Rate	.499	.277	.321	.515	.838***	.647	.137	.466	.803***	1.000					
11. YARC Comprehension	.298	.594*	.273	.670**	.663**	.778***	.357	.749**	.661**	.713**	1.000				
12. WASI Block Building	.310	.493	.004	.462	.301	.471	.727**	.620*	.027	.235	.638*	1.000			
13. WASI Vocabulary	.343	.536*	.515	.776***	.541*	.506	.268	.452	.824***	.691**	.827***	.292	1.000		
14. WASI Matrix Reasoning	.320	.731**	.418	.878***	.590*	.374	.404	.388	.705**	.559*	.762**	.509	.858***	1.000	
15. WASI Similarities	.005	.302	.450	.429	.196	.143	.034	.134	.061	.334	.402	.111	.351	.265	1.000

Notes: *p<.05, **p<.01, ***p<.001
DTWRP = Diagnostic Test of Word Reading Processes; PhAB = Phonological Assessment Battery, WASI = Weschler Abbreviated Scale of Intelligence

Table 6.4 Correlation matrix between the speech rhythm variables and outcome variables at Time 2 for children receiving the semantic -based intervention

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Stress	1.000														
2. Intonation	.287	1.000													
3. Timing	-.262	-.418	1.000												
4. Total Speech Rhythm	.641*	.626*	.158	1.000											
5. DTWRP Reading	-.141	-.204	.000	-.121	1.000										
6. PhAB Rhyme	.023	-.204	.028	-.209	.287	1.000									
7. PhAB Alliteration	.181	.129	.232	.376	.535	.637*	1.000								
8. PhAB Spoonerism	.450	.369	-.168	.428	.421	.633*	.842***	1.000							
9. YARC .Accuracy	-.242	-.417	-.089	-.443	.881***	.546	.418	.387	1.000						
10. YARC Rate	.358	-.205	-.125	.067	.574	.347	.259	.284	.561	1.000					
11. YARC Comprehension	.038	-.095	-.305	-.170	.469	.625*	.503	.491	.591	.539	1.000				
12. WASI Block Building	-.345	.085	.300	.074	.182	.267	.370	.312	.215	-.126	.379	1.000			
13. WASI Vocabulary	.138	.076	.106	.436	.448	-.189	.304	.137	.211	.500	.340	.130	1.000		
14. WASI Matrix Reasoning	-.549	-.286	.399	-.171	.128	.064	.241	-.106	.117	-.248	.312	.624*	.209	1.000	
15. WASI Similarities	.165	.212	.234	.385	.418	.295	.811**	.632*	.175	.009	.320	.350	.161	.222	1.000

Notes: *p<.05, **p<.01, ***p<.001
DTWRP = Diagnostic Test of Word Reading Processes; PhAB = Phonological Assessment Battery, WASI = Weschler Abbreviated Scale of Intelligence

The data will now be explored in relation to the research questions and hypothesis set out for this study.

Table 6.5 shows the means and standard deviations of change scores on single word reading, reading comprehension, rhyme awareness, alliteration awareness, spoonerism awareness, general intelligence and speech rhythm sensitivity for all three intervention groups between Time 1 and Time 2.

Table 6.5: Means and standard deviations of change scores between Time 1 and Time 2 for all three intervention groups on all variables

Variable	Group	Mean T1 score	SD	Mean T2 score	SD	Mean change T1:T2	SD
DTWRP Word Reading (/90)	SR	34.07	11.75	47.93	12.42	13.87	6.08
	PA	47.64	6.44	57.64	5.84	10.00	6.45
	Semantic	42.67	6.19	53.20	10.28	10.60	8.79
Rhyme Detection (/21)	SR	6.84	4.45	7.33	3.85	0.47	2.56
	PA	9.45	4.50	10.27	4.65	0.82	4.47
	Semantic	6.60	3.65	6.60	1.52	0.00	4.30
Alliteration Detection (/10)	SR	5.87	3.31	8.00	2.75	2.13	3.27
	PA	6.82	3.46	8.27	2.94	1.45	3.96
	Semantic	3.40	3.65	6.20	3.56	2.80	2.39
Spoonerism Detection (/10)	SR	5.73	3.35	7.93	2.15	2.20	2.54
	PA	7.73	2.10	9.36	0.81	1.64	2.34
	Semantic	4.80	3.19	5.80	3.90	1.00	1.22
YARC Accuracy	SR	37.93	6.99	41.60	5.73	3.67	7.15
	PA	40.82	7.76	45.91	3.65	5.09	6.46
	Semantic	37.60	3.85	45.40	4.93	7.80	5.45

YARC Rate	SR	41.47	17.02	44.07	13.30	2.60	15.40
	PA	50.18	16.66	54.09	10.96	3.91	11.29
	Semantic	38.80	22.64	53.80	13.55	15.00	19.49
YARC Compre-hension	SR	42.53	7.14	42.73	7.45	0.20	7.08
	PA	42.64	11.11	47.73	7.18	5.09	7.63
	Semantic	42.00	7.25	44.40	14.50	2.40	14.33
WASI Block Building	SR	14.07	8.31	22.40	10.68	8.33	6.95
	PA	17.09	6.83	22.73	6.34	5.64	5.26
	Semantic	15.08	6.61	21.40	8.82	5.60	3.21
WASI Vocabulary	SR	12.73	4.15	16.07	2.40	3.33	4.69
	PA	14.25	4.17	16.55	3.14	2.27	2.94
	Semantic	12.60	1.82	15.80	2.28	3.20	2.05
WASI Matrix Reasoning	SR	7.13	3.13	7.47	3.83	0.33	3.79
	PA	7.82	5.10	9.36	3.78	1.55	4.13
	Semantic	5.00	4.74	8.40	3.91	3.40	3.58
WASI Similarities	SR	10.17	4.67	15.27	2.28	5.20	5.27
	PA	13.91	4.99	15.45	2.38	1.55	2.88
	Semantic	12.80	5.93	15.00	3.39	2.20	3.11
Speech Rhythm - Stress Sensitivity (/5)	SR	4.00	1.25	5.00	0.00	1.00	1.25
	PA	4.09	1.14	4.73	0.47	0.64	1.12
	Semantic	3.60	1.14	4.00	1.00	0.40	0.55
Speech Rhythm - Intonation Sensitivity (/5)	SR	2.47	0.99	4.73	0.46	2.27	1.16
	PA	3.00	1.00	3.18	1.08	0.18	1.33
	Semantic	2.20	1.10	2.60	1.34	0.40	1.82
Speech Rhythm – Timing Sensitivity (/5)	SR	3.73	0.70	5.00	0.00	1.27	0.70
	PA	4.18	0.98	4.73	0.65	0.55	1.21
	Semantic	4.20	1.10	4.60	0.89	0.40	0.89
Speech Rhythm Total (/15)	SR	10.20	1.74	14.73	0.46	4.53	1.77
	PA	11.27	1.62	12.64	1.36	1.36	1.57
	Semantic	10.00	1.58	11.20	1.30	1.20	2.17

Notes: T1 = Time 1, T2 = Time 2, DTWRP = Diagnostic Test of Word Reading Processes, YARC = York Assessment of Reading Comprehension, WASI = Weschler Abbreviated Scale of Intelligence. Note that DTWRP and YARC are raw scores because the ability of the participants was too low to calculate standardised scores.

Table 6.5 illustrates the differences between the three intervention groups on their improvement in the assessed skills between the pre-test (Time 1) and the post-test (Time 2). Initial examination shows that children in the speech rhythm group had the lowest mean single word reading score at Time 1, but that these children also made the greatest mean improvement in single word reading between Time 1 and Time 2 when compared to children who received either the phonological awareness-based intervention or the semantic-based control intervention. In addition, children receiving the speech rhythm-based intervention also showed the greatest level of improvement between Time 1 and Time 2 on all aspects of speech rhythm sensitivity as would be expected. Surprisingly, results from the YARC accuracy assessment showed different results to that of the DTWRP reading assessment, with children in the phonological awareness group having the highest mean accuracy score at Time 1, and the semantic control group showing the greatest level of improvement between Time 1 and Time 2. Children receiving the phonological awareness-based intervention made the greatest mean improvement in rhyme awareness and reading comprehension, and these children had also performed at a greater level on these skills at Time 1. Children receiving the phonological awareness-based intervention also appeared to have the highest alliteration and spoonerism awareness at the baseline when compared to the other two groups. However, children in the semantic-based control group were the ones who made the greatest improvement on alliteration awareness between Time 1 and Time 2. The semantic group also showed large gains in reading rate as measured by the YARC, which were much larger than the gains in reading rate observed in either the speech rhythm group or the phonological awareness group. It is also observed that the semantic group had the lowest reading rate scores at Time 1. These findings will now be explored in more detail, in relation to the research questions set out at the beginning of this thesis.

6.3.2 Can training on a speech rhythm-based reading intervention help to improve word reading performance?

Table 6.5 illustrates that children who received training on the speech rhythm-based intervention could read an average of 13.87 words more at Time 2 than they could at Time 1, compared to a gain of 10 words in the phonological awareness group and 10.6 words in the semantic control group.

Data were inspected to ensure they met assumptions for parametric testing. All improvement variables were normally distributed and there were no issues with skew or kurtosis. ANOVA was conducted to compare the degree of change on each of the dependent variables between the three intervention groups. This showed that there was a significant main effect of intervention group on improvement in single word reading as measured by the DTWRP, $F(2, 47)=3.807$, $p=.030$, $\eta=.145$. This between groups difference remained after controlling for age, $F(2, 47)=3.211$, $p=.032$, $\eta=.180$, and individual differences in general intelligence, $F(2, 47)=4.752$, $p=.003$, $\eta=.307$. Tukey post hoc analyses revealed that the speech rhythm group improved significantly more than the semantic control group on their single word reading between Time 1 and Time 2 as expected ($p=.038$), and that there was no significant difference in single word reading improvement between children who received training on the speech rhythm-based intervention and children who received the phonological awareness-based intervention ($p=.116$). Additionally, there was no significant difference between children in the phonological awareness group and children in the semantic group in terms of their single word reading improvement ($p=.846$). Further ANOVA showed that there was no significant main effect of group on improvement in rhyme awareness, $F(2, 47)=.578$, $p=.565$, $\eta=.025$; alliteration awareness, $F(2, 47)=.703$, $p=.501$, $\eta=.030$; spoonerism awareness, $F(2, 47)=1.543$, $p=.225$, $\eta=.064$; reading accuracy, $F(2, 47)=.341$, $p=.714$, $\eta=.022$; reading rate, $F(2, 47)=.883$, $p=.423$, $\eta=.054$; reading comprehension, $F(2, 47)=1.190$, $p=.318$, $\eta=.071$; block building, $F(2, 47)=2.823$, $p=.070$, $\eta=.111$; vocabulary, $F(2, 47)=.656$, $p=.524$, $\eta=.028$; or matrix reasoning, $F(2, 47)=.221$, $p=.803$, $\eta=.010$. However there was a significant main effect of group on improvement on the similarities task, $F(2, 47)=3.991$, $p=.025$, $\eta=.151$, which remained when controlling for individual differences in general intelligence, $F(2, 47)=8.451$, $p<.001$, $\eta=.440$, but disappeared when age was controlled for, $F(2, 47)=2.694$, $p=.058$, $\eta=.155$. A final Tukey HSD analysis showed that the speech rhythm group outperformed the phonological awareness group on their improvement on the similarities task ($p=.033$), and that there was no significant difference between the speech rhythm group and the semantic control group ($p=.106$), or between the phonological awareness group and the semantic control group ($p=.919$) on this skill.

When we look at the improvements on each of the individual speech rhythm measures, we can observe that there was no significant main effect of treatment group on change in stress sensitivity between Time 1 and Time 2, $F(2, 47)=.831$, $p=.442$, $\eta=.036$. However, there was a significant difference between groups on change in intonation sensitivity, $F(2, 47)=12.572$, $p<.001$. As in the first study, whilst the children who took part in this study were all in the same year group, their ages ranged from just 7 years for those whose participation began in September, to around 8 and a half years for children whose participation began in part way through the school year. In order to control for individual differences that might occur due to the age of the participants, age was used as a control variable. We also controlled for individual differences in general intelligence using the WASI total scores at Time 1. This between groups difference in improvement in sensitivity to intonation remained after controlling for age, $F(2, 47)=11.753$, $p<.001$, $\eta=.445$, and after controlling for individual differences in general intelligence, $F(2, 47)=10.004$, $p<.001$, $\eta=.482$. Tukey HSD post hoc analyses showed that the speech rhythm group outperformed the phonological awareness group ($p<.001$) and the semantic control group ($p=.001$) on their improvement in sensitivity to intonation, but there was no significant difference between the phonological awareness group and the semantic control group ($p=.991$). There was also a significant difference between groups on their change in timing sensitivity, $F(2, 47)=4.860$, $p=.012$, which again remained after controlling for age, $F(2, 47)=4.133$, $p=.012$, $\eta=.219$, and also after controlling for individual differences in general intelligence, $F(2, 47)=3.042$, $p=.027$, $\eta=.221$. Tukey post hoc analyses again showed that the speech rhythm group outperformed the semantic control group on their improvement in sensitivity to timing ($p=.009$), but that there was no significant difference between the speech rhythm group and the phonological awareness group ($p=.384$), or between the phonological awareness group and the semantic control group ($p=.206$). These results had an effect on the change in overall speech rhythm sensitivity, in which we also observe a significant between groups difference, $F(2, 47)=14.966$, $p<.001$. This again remained when controlling for age, $F(2, 47)=11.730$, $p<.001$, $\eta=.444$, and individual differences in general intelligence, $F(2, 47)=8.855$, $p<.001$, $\eta=.452$. Tukey HSD analyses showed that the speech rhythm group improved significantly more than both the phonological awareness group ($p=.001$), and the semantic control group ($p<.001$) in overall speech rhythm sensitivity, but there was no significant difference between the phonological awareness group and the semantic control group ($p=.573$).

6.3.3 Were Improvements Maintained Over Time?

We must now consider whether these improvement rates were maintained once the intervention period was terminated. Table 6.6 shows the mean and standard deviation of change scores on all variables for children in each of the intervention groups between Time 2 and Time 3.

Table 6.6 Mean changes between the post-test (Time 2) and the delayed post-test (Time 3) for all three intervention groups.

Variable	Group	Mean T2 score	SD	Mean T3 score	SD	Mean change T2:T3	SD
DTWRP Word Reading (/90)	SR	47.93	12.42	51.13	12.83	3.20	6.74
	PA	57.64	5.84	58.00	7.60	0.36	5.08
	Semantic	53.20	10.28	54.60	12.56	1.40	4.93
Rhyme Detection (/21)	SR	7.33	3.85	9.13	4.78	1.80	2.83
	PA	10.27	4.65	9.73	4.13	-0.55	3.05
	Semantic	6.60	1.52	8.40	4.04	1.80	3.83
Alliteration Detection (/10)	SR	8.00	2.75	8.13	2.26	0.13	2.75
	PA	8.27	2.94	9.64	0.67	1.36	2.98
	Semantic	6.20	3.56	6.80	3.96	0.60	2.41

Spoonerism Detection (/10)	SR	7.93	2.15	8.73	1.33	0.80	1.47
	PA	9.36	0.81	9.00	1.34	-0.36	1.36
	Semantic	5.80	3.90	7.60	2.30	1.80	2.17
YARC Accuracy	SR	41.60	5.73	42.93	7.90	1.33	4.97
	PA	45.91	3.65	48.09	3.33	2.18	2.93
	Semantic	45.40	4.93	46.00	4.00	0.60	3.51
YARC Rate	SR	44.07	13.30	46.47	12.99	2.40	7.63
	PA	54.09	10.96	59.82	12.29	5.73	5.44
	Semantic	53.80	13.55	61.00	12.33	7.20	7.85
YARC Compre-hension	SR	42.73	7.45	44.60	8.99	1.87	7.70
	PA	47.73	7.18	50.27	7.73	2.55	3.96
	Semantic	44.40	14.50	49.60	5.73	5.20	12.36
WASI Block Building	SR	22.40	10.68	26.13	11.58	3.73	8.14
	PA	22.73	6.34	25.27	5.04	2.55	4.78
	Semantic	21.40	8.82	17.40	6.99	-4.00	1.87
WASI Vocabulary	SR	16.07	2.40	16.13	1.68	0.67	2.69
	PA	16.55	3.14	16.18	2.14	-0.36	2.62
	Semantic	15.80	2.28	15.20	1.10	-0.60	1.34
WASI Matrix Reasoning	SR	7.47	3.83	8.73	4.06	1.27	4.13
	PA	9.36	3.78	10.64	5.16	1.27	2.61
	Semantic	8.40	3.91	10.20	1.92	1.80	4.66
WASI Similarities	SR	15.27	2.28	15.07	1.49	-0.20	2.24
	PA	15.45	2.38	16.55	2.07	1.09	2.30
	Semantic	15.00	3.39	15.60	3.85	0.60	3.78
Speech Rhythm - Stress Sensitivity (/5)	SR	5.00	0.00	5.00	0.00	0.00	0.00
	PA	4.73	0.47	4.91	0.30	0.18	0.60
	Semantic	4.00	1.00	4.60	0.89	0.60	0.89

Speech Rhythm - Intonation Sensitivity (/5)	SR	4.73	0.46	4.47	0.92	-0.27	0.88
	PA	3.18	1.08	3.45	1.21	0.27	1.85
	Semantic	2.60	1.34	3.40	1.52	0.80	1.30
Speech Rhythm – Timing Sensitivity (/5)	SR	5.00	0.00	4.87	0.35	-0.13	0.35
	PA	4.73	0.65	4.09	1.30	-0.64	1.50
	Semantic	4.60	0.89	3.80	1.10	-0.80	0.45
Speech Rhythm Total (/15)	SR	14.73	0.46	14.33	0.90	-0.40	0.74
	PA	12.64	1.36	12.45	2.34	-0.18	2.71
	Semantic	11.20	1.30	11.80	1.30	0.60	1.14

Notes: T2 = Time 2, T3 = Time 3, DTWRP = Diagnostic Test of Word Reading Processes, YARC = York Assessment of Reading Comprehension, WASI = Weschler Abbreviated Scale of Intelligence. Note that DTWRP and YARC are raw scores because the ability of the participants was too low to calculate standardised scores.

Table 6.6 illustrates the improvement made by children in each of the three intervention groups on each of the assessed skills between the post-test (Time 2), immediately after the intervention, and the delayed post-test (Time 3), three months after the end of the intervention period. Initial examination of the data shows that children in each of the intervention groups continued to improve on their single word reading performance between Time 2 and Time 3. Children in the phonological awareness group appeared to perform at the highest rate on the DTWRP at Time 2, immediately following the intervention period, and continued to be the highest performers on this task at Time 3. However, it should also be noted that table 6.5 shows this group also performed at the highest rate on this assessment at Time 1. Further examination of change scores shows that it was the speech rhythm group who made the largest gain in performance on the DTWRP between Time 2 and Time 3, suggesting that once the interventions are terminated, children who have been exposed to a speech rhythm-based intervention continue to make larger gains in single word reading performance than children exposed to either a phonological awareness-based intervention or a semantic-based control intervention. Surprisingly, it was the phonological awareness group that improved the most on the reading accuracy measure of the YARC between Time 2 and Time 3, although all groups did continue to improve. Also on the YARC, the semantic group made the largest gains in reading rate, resulting in a higher performance in this skill at Time 3 than either of the other two groups. Similarly, it was the semantic group who improved most in their reading comprehension between Time 2 and Time 3, whilst the speech rhythm group made the least improvement.

When we look at the phonological awareness measures, we can observe that children in the phonological awareness group made the largest improvement in alliteration awareness, but showed a decline in rhyme awareness and spoonerism awareness once the interventions were terminated. Children who received either the speech rhythm or semantic-based intervention made similar gains in rhyme awareness between Time 2 and Time 3. In addition, it was the semantic control group that made the largest gains in performance on the spoonerism awareness assessment at this stage, but this group also remained the lowest scorers on this task at both Time 2 and Time 3.

The general intelligence measures on the WASI showed that the speech rhythm group and phonological awareness group continued to improve on the block building task once the interventions were terminated, whilst the semantic control group showed a decline in performance on this task. On the vocabulary assessment, both the phonological awareness group and the semantic control group showed a decline in performance between Time 2 and Time 3, but the speech rhythm group continued to improve, and all groups showed continued improvement in matrix reasoning. Finally, the phonological awareness group and the semantic group continued to improve on the similarities assessment but the speech rhythm group showed a decline in performance on this task.

When we consider the speech rhythm measures, the children who received training on the speech rhythm-based intervention remained at ceiling level on the stress task at Time 3, and the other two groups continued to improve on this skill once the interventions were terminated. However, the speech rhythm group showed a decline in performance in sensitivity to intonation, whilst the other two groups showed continued improvement. Finally, all groups declined in performance on the timing task once interventions were terminated. Overall speech rhythm sensitivity declined in both the speech rhythm group and the phonological awareness group between Time 2 and Time 3, suggesting that continued training of either kind may be required to maintain the level of speech rhythm sensitivity. However, what was surprising was that the semantic group showed a slight improvement in overall speech rhythm sensitivity within this same time frame.

6.3.4 Were these group differences significant?

ANOVA was conducted to compare the improvement rates of all three intervention groups on each of the assessed skills between Time 2 and Time 3 (i.e. how much children continued to improve on each skill once the intervention period had ended). Table 6.6 shows that children in the speech rhythm group could read an average of 3.20 words more at Time 3 than they could at Time 2, whereas the phonological awareness group only made an average improvement of 0.36 words, and the semantic control group improved by an average of 1.40 words. ANOVA revealed that there was no significant difference between any of the groups on their improvement in single word reading performance between Time 2 and Time 3, $F(2, 47)=1.034$, $p=.364$, $\eta=.046$. Similarly, there was no significant difference between groups on their change in rhyme awareness, $F(2, 47)=.829$, $p=.444$, $\eta=.037$; alliteration awareness, $F(2, 47)=.575$, $p=.567$, $\eta=.026$; spoonerism awareness, $F(2, 47)=1.382$, $p=.262$, $\eta=.060$; reading accuracy as measured by the YARC, $F(2, 47)=.007$, $p=.993$, $\eta=.000$; reading comprehension, $F(2, 47)=.036$, $p=.965$, $\eta=.026$; the block building task on the WASI, $F(2, 47)=.503$, $p=.608$, $\eta=.023$; vocabulary as measured by the WASI, $F(2, 47)=.356$, $p=.703$, $\eta=.016$; matrix reasoning, $F(2, 47)=.687$, $p=.509$, $\eta=.031$; the WASI similarities assessment, $F(2, 47)=1.558$, $p=.222$, $\eta=.068$; sensitivity to stress, $F(2, 47)=1.943$, $p=.156$, $\eta=.083$; sensitivity to intonation, $F(2, 47)=1.355$, $p=.269$, $\eta=.059$; sensitivity to timing, $F(2, 47)=1.525$, $p=.229$, $\eta=.066$; or overall speech rhythm sensitivity, $F(2, 47)=1.649$, $p=.204$, $\eta=.071$. This lack of significant between group differences indicates that all three groups made similar improvements on all of these assessed skills between Time 2 and Time 3, once the interventions were terminated. The only measure where a significant between groups difference was present between Time 2 and Time 3 was reading rate as measured by the YARC, $F(2, 47)=3.981$, $p=.028$, $\eta=.185$, and this remained after controlling for age, $F(2, 47)=3.216$, $p=.035$, $\eta=.221$, but disappeared when individual differences in general intelligence were also controlled for, $F(2, 47)=2.416$, $p=.068$, $\eta=.227$. A Tukey HSD post hoc analysis revealed that the semantic control group improved significantly more than the speech rhythm group on this measure between Time 2 and Time 3 ($p=.043$), but that there was no significant difference between the speech rhythm group and the phonological awareness group (p=.104), or between the phonological awareness group and the semantic control group (p=.704) on this measure.

6.3.5 How did groups differ in their long term gains?

In order to determine if there were any long term gains in reading skills as a result of training, it is also important to consider the overall improvement rates between the baseline at Time 1 and the delayed post-test at Time 3. Table 6.7 shows the mean and standard deviation of change scores on single word reading, reading comprehension, rhyme awareness, alliteration awareness, spoonerism awareness, general intelligence and speech rhythm sensitivity for all three intervention groups between Time 1 and Time 3.

Table 6.7 Mean changes between the pre-test (Time 1) and the delayed post-test (Time 3) for all three intervention groups.

Variable	Group	Mean T1 score	SD	Mean T3 score	SD	Mean change T1:T3	SD
DTWRP Word Reading (/90)	SR	34.07	11.75	51.13	12.83	17.07	4.83
	PA	47.64	6.44	58.00	7.60	10.36	5.87
	Semantic	42.67	6.19	54.60	12.56	12.00	11.55
Rhyme Detection (/21)	SR	6.84	4.45	9.13	4.78	2.27	3.26
	PA	9.45	4.50	9.73	4.13	0.27	4.69
	Semantic	6.60	3.65	8.40	4.04	1.80	3.42
Alliteration Detection (/10)	SR	5.87	3.31	8.13	2.26	2.27	3.15
	PA	6.82	3.46	9.64	0.67	2.82	3.76
	Semantic	3.40	3.65	6.80	3.96	3.40	3.85

Spoonerism Detection (/10)	SR	5.73	3.35	8.73	1.33	3.00	3.30
	PA	7.73	2.10	9.00	1.34	1.27	2.00
	Semantic	4.80	3.19	7.60	2.30	2.80	1.30
YARC Accuracy	SR	37.93	6.99	42.93	7.90	5.00	8.00
	PA	40.82	7.76	48.09	3.33	7.27	5.80
	Semantic	37.60	3.85	46.00	4.00	8.40	2.61
YARC Rate	SR	41.47	17.02	46.47	12.99	5.00	15.08
	PA	50.18	16.66	59.82	12.29	9.64	12.16
	Semantic	38.80	22.64	61.00	12.33	22.20	13.79
YARC Compre-hension	SR	42.53	7.14	44.60	8.99	2.07	10.59
	PA	42.64	11.11	50.27	7.73	7.64	6.53
	Semantic	42.00	7.25	49.60	5.73	7.60	5.59
WASI Block Building	SR	14.07	8.31	26.13	11.58	12.07	8.52
	PA	17.09	6.83	25.27	5.04	8.18	5.31
	Semantic	15.08	6.61	17.40	6.99	1.60	1.82
WASI Vocabulary	SR	12.73	4.15	16.13	1.68	3.40	3.54
	PA	14.25	4.17	16.18	2.14	1.91	3.96
	Semantic	12.60	1.82	15.20	1.10	2.60	1.14
WASI Matrix Reasoning	SR	7.13	3.13	8.73	4.06	1.60	4.53
	PA	7.82	5.10	10.64	5.16	2.82	4.49
	Semantic	5.00	4.74	10.20	1.92	5.20	5.07
WASI Similarities	SR	10.17	4.67	15.07	1.49	5.00	5.10
	PA	13.91	4.99	16.55	2.07	2.64	4.39
	Semantic	12.80	5.93	15.60	3.85	2.80	4.38
Speech Rhythm - Stress Sensitivity (/5)	SR	4.00	1.25	5.00	0.00	1.00	1.25
	PA	4.09	1.14	4.91	0.30	0.82	1.08
	Semantic	3.60	1.14	4.60	0.89	1.00	0.71

Speech Rhythm - Intonation Sensitivity (/5)	SR	2.47	0.99	4.47	0.92	2.00	1.51
	PA	3.00	1.00	3.45	1.21	0.45	1.44
	Semantic	2.20	1.10	3.40	1.52	1.20	1.79
Speech Rhythm – Timing Sensitivity (/5)	SR	3.73	0.70	4.87	0.35	1.13	0.83
	PA	4.18	0.98	4.09	1.30	-0.09	1.70
	Semantic	4.20	1.10	3.80	1.10	-0.40	0.89
Speech Rhythm Total (/15)	SR	10.20	1.74	14.33	0.90	4.13	2.07
	PA	11.27	1.62	12.45	2.34	1.18	2.56
	Semantic	10.00	1.58	11.80	1.30	1.80	1.30

Notes: T1 = Time 1, T3 = Time 3, DTWRP = Diagnostic Test of Word Reading Processes, YARC = York Assessment of Reading Comprehension, WASI = Weschler Abbreviated Scale of Intelligence. Note that DTWRP and YARC are raw scores because the ability of the participants was too low to calculate standardised scores.

Initial examination of Table 6.7 reveals that children who received the speech rhythm-based intervention improved in their single word reading by an average of 17.07 words on the DTWRP between the baseline at Time 1 and the delayed post-test at Time 3, compared to children who received the phonological awareness-based intervention who improved by an average of 10.36 words, and the semantic control group who improved by an average of 12 words. The speech rhythm group were also the group who improved the most on rhyme awareness and spoonerism awareness, whereas it was the semantic group that showed the greatest overall improvement in alliteration awareness. The semantic group also showed the greatest improvement in reading accuracy and reading rate on the YARC, with a large difference between groups in their improvement in reading rate. We can also observe that the phonological awareness group made the greatest improvement in reading comprehension, although this gain was only marginally larger than that of the semantic group. On the WASI, the speech rhythm group improved most on the block building task, the vocabulary assessment, and the similarities assessment, and it was the semantic group that improved the most on matrix reasoning. Finally, as expected, the speech rhythm group made the largest overall improvement on all of the speech rhythm measures and overall speech rhythm sensitivity.

6.3.6 Are these group differences significant?

ANOVA was conducted to compare the groups on their overall improvement on all of the assessed skills between Time 1 and Time 3. Table 6.7 shows that the speech rhythm group made the greatest overall improvement in single word reading out of the three groups, and ANOVA revealed that there was in fact a significant between groups difference on overall change in reading performance between Time 1 and Time 3, $F(2, 47)=5.286$, $p=.009$, $\eta=.194$, which remained after controlling for age, $F(2, 47)=5.290$, $p=.003$, $\eta=.270$, and individual differences in general intelligence, $F(2, 47)=5.200$, $p=.002$, $\eta=.331$. Tukey HSD post-hoc analyses revealed that the speech rhythm group had outperformed the phonological awareness group in their overall gain in single word reading performance between Time 1 and Time 3 ($p=.012$). However, there was no significant difference between the speech rhythm group and the semantic control group ($p=.061$), nor between the phonological awareness group and the semantic control group ($p=.897$). Further examination of ANOVA results showed that there was no significant differences between groups on their overall improvement in rhyme awareness, $F(2, 47)=1.774$, $p=.182$, $\eta=.075$; alliteration awareness, $F(2, 47)=.332$, $p=.719$, $\eta=.015$; spoonerism awareness, $F(2, 47)=1.842$, $p=.170$, $\eta=.077$; reading accuracy as measured by the YARC, $F(2, 47)=.642$, $p=.534$, $\eta=.044$; reading rate, $F(2, 47)=2.867$, $p=.074$, $\eta=.170$; reading comprehension, $F(2, 47)=1.579$, $p=.224$, $\eta=.101$; the WASI block building task, $F(2, 47)=2.303$, $p=.112$, $\eta=.095$; vocabulary, $F(2, 47)=.798$, $p=.457$, $\eta=.035$; matrix reasoning, $F(2, 47)=.064$, $p=.938$, $\eta=.003$; or the WASI similarities assessment, $F(2, 47)=1.202$, $p=.310$, $\eta=.052$.

When we look at the individual measures of speech rhythm, we can observe that there was no significant difference between the three intervention groups in their overall gain in stress sensitivity, $F(2, 47)=.113$, $p=.894$, $\eta=.005$. There was, however, a significant difference between groups in their overall gain in intonation sensitivity, $F(2, 47)=7.795$, $p=.001$, $\eta=.262$, which remained after controlling for age, $F(2, 47)=5.248$, $p=.004$, $\eta=.268$, and individual differences in general intelligence, $F(2, 47)=6.820$, $p<.001$, $\eta=.394$. Tukey HSD analyses revealed that the speech rhythm group improved significantly more on their intonation sensitivity between Time 1 and Time 3 than both the phonological awareness group ($p=.004$) and the semantic control group ($p=.007$), and that there was no significant difference between the level of improvement made by the phonological awareness group and the semantic control group on this skill ($p=.998$). There was also a significant difference between groups on their overall improvement in sensitivity to timing between Time 1 and Time 3, $F(2, 47)=3.981$, $p=.026$, $\eta=.153$, which remained after controlling for age, $F(2, 47)=3.485$, $p=.024$, $\eta=.196$, and after controlling for individual differences in general intelligence, $F(2, 47)=2.667$, $p=.045$, $\eta=.203$. Tukey HSD analyses showed that the speech rhythm group improved significantly more than the semantic control group on this skill between Time 1 and Time 3 ($p=.048$), but that there was no significant difference between the speech rhythm group and the phonological awareness group ($p=.070$), nor between the phonological awareness group and the semantic control group ($p=.954$) on this measure between Time 1 and Time 3. Finally, ANOVA revealed that there was a significant difference between groups on their overall improvement in total speech rhythm sensitivity between the baseline at Time 1 and the delayed post-test at Time 3, $F(2, 47)=10.978$, $p<.001$, $\eta=.333$. This between groups difference remained highly significant when controlling for both age, $F(2, 47)=7.154$, $p=.001$, $\eta=.333$, and individual differences in general intelligence, $F(2, 47)=6.702$, $p<.001$, $\eta=.390$. A final look at the Tukey HSD post-hoc analyses shows that, as expected, children who received the speech rhythm-based intervention improved significantly more on their total speech rhythm sensitivity in the long term than children who received then phonological awareness-based intervention ($p=.001$), and children who received the semantic control intervention ($p=.001$), but that there was no significant difference in overall speech rhythm sensitivity improvement between children in the phonological awareness group and children in the semantic control group ($p=.916$).

6.3.7 What are the Observable Characteristics of Children who Benefitted Most from the Speech Rhythm Based Intervention?

The children who displayed the largest gains (gains of 10 words or more) in their single word reading performance between Time 1 and Time 2 were isolated for further analyses. The characteristics of the children who benefited from exposure to the speech rhythm intervention (N=15) were compared to the characteristics of children who benefited from exposure to the phonological awareness based intervention (N=7) to determine if literacy skills at Time 1 influenced their response to different types of intervention (see Table 6.8)

Table 6.8: Means and standard deviations of all pre-test assessment scores for children who showed an improvement in reading performance of 10 words or more at Time 2.

Variable	Group	Response Rate	Mean Pre-Test Score	SD
DTWRP Raw Score (/90)	SR	High	32.18	12.06
		Low	39.25	10.53
	PA	High	44.50	6.86
		Low	51.40	3.51
PhAB Rhyme Awareness (/21)	SR	High	6.45	4.84
		Low	8.00	3.46
	PA	High	9.00	4.34
		Low	10.00	5.15
PhAB Alliteration Awareness (/10)	SR	High	5.27	3.72
		Low	7.50	0.58
	PA	High	6.50	3.62
		Low	7.20	3.63
PhAB Spoonerism Awareness (/10)	SR	High	5.91	3.08
		Low	5.25	4.50
	PA	High	8.00	2.28
		Low	7.40	2.07
YARC Accuracy	SR	High	38.00	8.12
		Low	37.75	2.87
	PA	High	39.50	8.22
		Low	42.40	7.77
YARC Rate	SR	High	40.09	19.78
		Low	42.25	4.57
	PA	High	47.17	16.88
		Low	53.80	17.54
YARC Comprehension	SR	High	42.82	5.21
		Low	41.75	12.09
	PA	High	41.83	11.58
		Low	43.60	11.78
WASI Block Building	SR	High	16.45	8.38

		Low	7.50	3.11
	PA	High	18.17	9.37
		Low	15.80	1.79
WASI Vocabulary	SR	High	11.73	4.13
		Low	15.50	3.11
	PA	High	12.17	3.06
		Low	16.80	4.15
WASI Matrix Reasoning	SR	High	7.36	3.78
		Low	6.50	1.73
	PA	High	8.50	6.57
		Low	7.00	3.08
WASI Similarities	SR	High	10.27	5.18
		Low	9.50	3.42
	PA	High	13.33	5.92
		Low	14.60	4.16
Speech Rhythm - Stress Sensitivity (/5)	SR	High	4.27	1.01
		Low	3.25	1.71
	PA	High	3.83	1.33
		Low	4.40	0.89
Speech Rhythm - Intonation Sensitivity (/5)	SR	High	2.27	0.79
		Low	3.00	1.41
	PA	High	2.50	0.84
		Low	3.60	0.89
Speech Rhythm - Timing Sensitivity (/5)	SR	High	3.73	0.79
		Low	3.75	0.50
	PA	High	4.17	1.17
		Low	4.20	0.84
Speech Rhythm Sensitivity Total (/15)	SR	High	10.27	1.68
		Low	10.00	2.16
	PA	High	10.50	1.52
		Low	12.20	1.30

Notes: DTWRP = Diagnostic Test of Word Reading Processes, YARC = York Assessment of Reading Comprehension, WASI = Weschler Abbreviated Scale of Intelligence.

As can be seen from Table 6.8, participants who benefitted from exposure to the speech rhythm intervention appeared to have lower single word reading abilities at Time 1 than those who benefitted most from exposure to the phonological awareness based intervention. Furthermore, those whose reading benefitted from exposure to the phonological awareness based intervention appeared to have better phonological awareness and general intelligence at Time 1 than those whose reading benefitted from exposure to the speech rhythm intervention.

An ANOVA was conducted to determine if these differences were significant, and showed that there was no significant difference between the children who benefitted from exposure to the speech rhythm-based intervention (N=15) and children who benefitted from exposure to the phonological awareness-based intervention (N=7) in terms of their pre-test single word reading ability, $F(1, 21)=3.466$, $p=.077$, $\eta=.148$, rhyme awareness, $F(1, 21)=1.748$, $p=.202$, $\eta=.080$, alliteration awareness, $F(1, 21)=.393$, $p=.538$, $\eta=.019$, spoonerism awareness, $F(1, 21)=3.198$, $p=.089$, $\eta=.138$, reading accuracy, $F(1, 21)=.410$, $p=.529$, $\eta=.020$, reading rate, $F(1, 21)=.546$, $p=.471$, $\eta=.035$, reading comprehension, $F(1, 21)=.067$, $p=.799$, $\eta=.003$, block building, $F(1, 21)=.046$, $p=.832$, $\eta=.002$, vocabulary, $F(1, 21)=.450$, $p=.510$, $\eta=.022$, matrix reasoning, $F(1, 21)=.382$, $p=.544$, $\eta=.019$, the similarities task, $F(1, 21)=1.594$, $p=.221$, $\eta=.074$, stress sensitivity, $F(1, 21)=.682$, $p=.419$, $\eta=.033$, intonation sensitivity, $F(1, 21)=.248$, $p=.624$, $\eta=.012$, timing sensitivity, $F(1, 21)=1.014$, $p=.326$, $\eta=.048$, or overall speech rhythm sensitivity, $F(1, 21)=.066$, $p=.800$, $\eta=.003$. Additionally, further ANOVA revealed no significant differences between children whose reading did benefit from exposure to the speech rhythm-based intervention (N=15), and children whose reading did not benefit from exposure to the speech rhythm-based intervention (N=5) in terms of their pre-test single word reading ability, $F(1, 19)=.279$, $p=.604$, $\eta=.015$, rhyme awareness, $F(1, 19)=.266$, $p=.612$, $\eta=.015$, alliteration awareness, $F(1, 19)=.755$, $p=.396$, $\eta=.040$, spoonerism awareness, $F(1, 19)=.351$, $p=.561$, $\eta=.019$, reading accuracy, $F(1, 19)=.009$, $p=.925$, $\eta=.001$, reading rate, $F(1, 19)=.255$, $p=.622$, $\eta=.019$, reading comprehension, $F(1, 19)=.014$, $p=.906$, $\eta=.001$, matrix reasoning, $F(1, 19)=.433$, $p=.519$, $\eta=.024$, the similarities task, $F(1, 19)=.108$, $p=.745$, $\eta=.006$, stress sensitivity, $F(1, 19)=.429$, $p=.521$, $\eta=.023$, intonation sensitivity, $F(1, 19)=2.909$, $p=.105$, $\eta=.139$, timing sensitivity, $F(1, 19)=.031$, $p=.863$, $\eta=.002$, or total speech rhythm sensitivity, $F(1, 19)=.440$, $p=.515$, $\eta=.024$. However, there was a significant difference between children who benefitted and children who did not benefit from exposure to the speech rhythm-based intervention in terms of their performance on the block building task, $F(1, 19)=4.845$, $p=.041$, $\eta=.212$, where those who benefitted had significantly higher block building performance at Time 1 than those who did not benefit. There was also a significant difference between children who benefitted and children who did not benefit from exposure to the speech rhythm-based intervention in terms of their pre-test vocabulary, $F(1, 19)=4.631$, $p=.045$, $\eta=.205$, where children who benefitted from the speech rhythm-based intervention had significantly lower vocabulary scores at Time 1 than children who did not benefit. A final batch of ANOVAs showed that there were no significant differences between children who did benefit ($N=7$) and children who did not benefit ($N=8$) from exposure to the phonological awareness-based intervention on any of their pre-test skills, including single word reading performance, $F(1, 14)=.024$, $p=.880$, $\eta=.002$, rhyme awareness, $F(1, 14)=.097$, $p=.760$, $\eta=.007$, alliteration awareness, $F(1, 14)=.011$, $p=.920$, $\eta=.001$, spoonerism awareness, $F(1, 14)=1.623$, $p=.225$, $\eta=.111$, reading accuracy, $F(1, 14)=.002$, $p=.968$, $\eta=.000$, reading rate, $F(1, 14)=.407$, $p=.540$, $\eta=.043$, reading comprehension, F(1, 14)=.106, p=.750, η=.008, block building, F(1, 14)=.403, p=.537, η=.030, vocabulary, F(1, 14)=.239, p=.633, η=.018, matrix reasoning, F(1, 14)=.861, p=.370, η=.062, the similarities task, F(1, 14)=.005, p=.945, η=.000, stress sensitivity, F(1, 14)=.005, p=.944, η=.000, intonation sensitivity, F(1, 14)=1.613, p=.226, η=.110, timing sensitivity, F(1, 14)=.522, p=.483, η=.039, or overall speech rhythm sensitivity, F(1,14)=.087, p=.772, η=.007.

6.3.8 Week-by-Week Learning Profiles

As in the first study, notes were kept each week of how well the children were performing on the tasks which the three different interventions were based on. These data were examined to see the extent to which the children were responding to the treatments during the intervention period. This week-by-week data showed that all children tended to show a steady improvement in performance throughout the intervention period (see Figure 6.1).

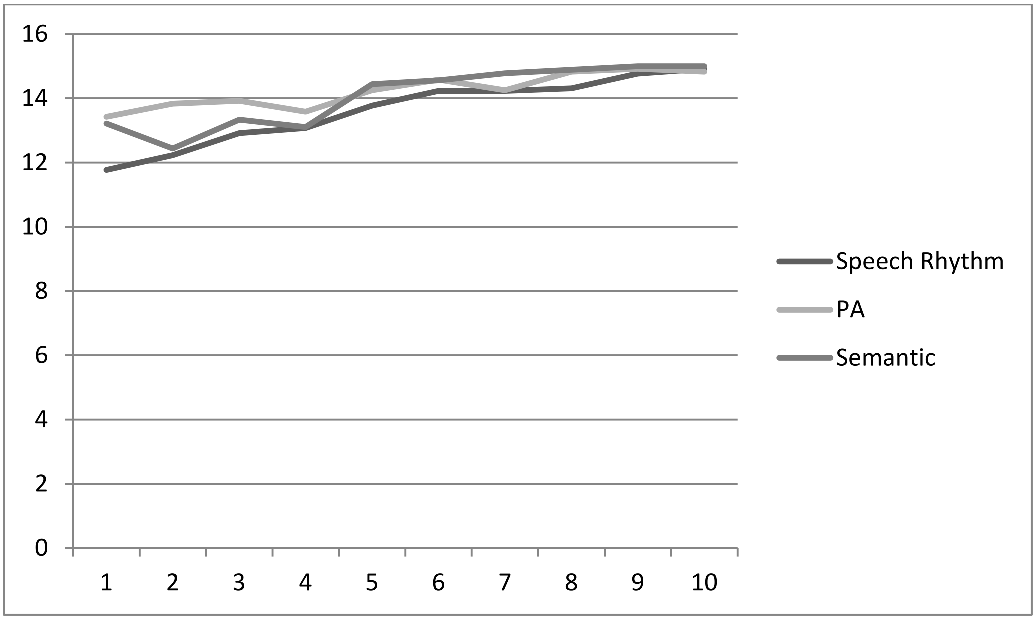

Figure 6.1 Line graph illustrating week by week improvements for each intervention group

6.4 Discussion

This study set out to determine whether training on a speech rhythm-based intervention could benefit the reading performance of 7-8 year old children who performed below the level we would expect on a standardised reading assessment and were therefore falling below the expected reading level for children in their age group. Through this, the study aimed to discover (a) whether training on a set of activities which aimed to improve children’s sensitivity to speech rhythm could benefit their reading development, (b) whether these activities could result in gains that were equivalent to those observed by a more traditional phonological-based intervention, and (c) whether the observable characteristics of children who benefitted the most from the speech rhythm-based intervention differed from children who benefitted from exposure to a more traditional phonologically-based intervention.

Findings showed that training on the speech rhythm-based intervention resulted in significant gains in speech rhythm sensitivity compared to both the phonological awareness-based intervention and the semantic-based control. This was expected due to the nature of the training involved in the speech rhythm intervention, which taught children specifically about the components of speech rhythm that were later assessed. When we look closer at the individual components of speech rhythm however, we can observe a different pattern of results for each of the individual elements. It was found that there was no significant difference between groups on their improvement in sensitivity to stress, but that there was a significant difference between the speech rhythm group and the phonological awareness group, and also between the speech rhythm group and the semantic control group on their improvement in sensitivity to intonation. This illustrates that training on the speech rhythm intervention has the potential to influence intonation sensitivity individually, regardless of improvements in sensitivity to stress and timing, suggesting that intonation may be more sensitive to prosodic training. Further to this, there was also a significant difference between the speech rhythm group and the semantic control group on their improvement in sensitivity to timing, suggesting that training on a speech rhythm-based intervention can also affect sensitivity to timing individually, although the lack of significant difference between the speech rhythm group and the phonological awareness group on this measure suggests that this element is not so dependent on specific training as intonation appears to be. These differing results for each of the individual components of speech rhythm sensitivity support the idea that speech rhythm is not a unitary construct. This is consistent with the findings of Study 1, where different results were also observed for each of the different components of speech rhythm. In additional support for this idea, we can observe from the correlation matrices presented in Tables 6.1, 6.2, 6.3 and 6.4 that none of the components of speech rhythm were significantly correlated with one another either at the pre-test or the post-test for any of the groups. This suggests that stress, intonation and timing may each play a unique role in literacy development, and that sensitivity to stress may not necessarily imply sensitivity to intonation and timing. This is controversial to many studies which have focused on measuring the single component of stress and assuming an overall measure of prosody (e.g. Wood, 2006) and illustrates that we cannot assume overall speech rhythm sensitivity from measuring these components on an individual basis.

In relation to the aims of this study, findings also showed that training on the speech rhythm-based intervention resulted in significant gains in single word reading performance when compared to the semantic control group, supporting the hypothesis that training on the speech rhythm-based intervention could result in higher gains in reading performance than a control intervention. In addition, there was no significant difference observed between the speech rhythm group and the phonological awareness group, suggesting that these two types of intervention had a similar impact on children's reading performance. This suggests that training on a speech rhythm-based intervention can be just as effective as more established methods of reading tuition for improving the word reading abilities of 7-8 year old children who are struggling with reading. However, the lack of significant difference in improvement in reading between the phonological awareness group and the semantic control group was surprising, and suggests that the phonological awareness-based intervention was not as effective as we would expect for improving word reading performance. It is possible that training on the phonological awareness based intervention was over-ruled by phonological awareness training that was already taking place in the classroom, leading to this lack of difference between the two groups. What was perhaps more surprising was the lack of significant difference between any of the groups on their improvement in phonological awareness. Again, it is possible that existing classroom activities training children's phonological awareness could over-ride any additional training that was administered as part of the intervention. However it is also possible that the training materials administered as part of the phonological awareness intervention were not exclusively related to the tools used to assess the children's phonological awareness at the pre- and post-test. The assessment tools used included the rhyme, alliteration and spoonerisms subtests of the Phonological Assessment Battery, and whilst these do assess components of phonological awareness, the materials used in the phonological intervention included more letter based tasks from *Jolly Phonics* training, and did not specifically focus on the assessed elements of rhyming, alliteration or spoonerisms. Despite the fact that this intervention had been altered from the phonological awareness-based intervention chosen for Study 1, then, it appeared that the phonological interventions in both studies provided similar results. It is also possible, as suggested in chapter 5.4, that ten weeks may not have been long enough for the phonological awareness training to have an impact, especially given that children in this study only received a total of 150minutes of direct tuition time. Another possible explanation for this finding relates to the fact that the children who took part in this study had already been shown to be falling behind with their reading performance. As these children were already in year 3, they had already received some formal reading tuition in school which taught phonological awareness skills, and if they had responded in the way we would expect to this training, they would not be struggling readers. It is possible that this method of tuition just wasn't adequate enough for these children to gain the skills necessary to become successful readers, and so administering more of this type of tuition during the intervention phase was not benefitting them any more than the tuition which they were already receiving in class. We can relate this back to the theory outlined in section 2.2, where it was proposed that children need to be aware of the suprasegmental elements of language before they can successfully acquire segmental phonological awareness. It is suggested that these children were not responding to phonological awareness training because they did not have the suprasegmental foundations to build upon, and without suprasegmental knowledge, segmental phonological awareness training would be unsuccessful. The theory in section 2.2 also suggests that having suprasegmental phonological awareness (i.e. speech rhythm sensitivity) enables children to gain segmental phonological awareness and subsequently become successful readers. If this is the case, we would expect to observe that children who had received speech rhythm training would benefit in terms of their phonological awareness because they were still receiving phonological awareness training in class as part of their curriculum, regardless of the intervention group they were placed into for the duration of this study. However, the lack of significant differences between any of the groups on their improvement in phonological awareness between the pre- and post-test suggests that all groups improved at similar rates on these skills regardless of the type of training they received.

When we considered the delayed follow up data, it was revealed that there were no significant differences between groups on their improvement in reading skills between time 2 and time 3, suggesting that between group differences in improvement rate that were observed between time 1 and time 2 were not maintained at the delayed follow-up. The obvious explanation to this is that when training was terminated, children’s improvement rates on various skills slowed down so that other children were able to catch up, suggesting that those who struggle with reading need continued treatment to maintain their improvement rate.

In order to fully evaluate the effectiveness of the speech rhythm-based intervention in the long term, further analysis was conducted to determine how effective the interventions were at improving literacy skills overall, between the pre-test and the delayed follow up. What was interesting was that the speech rhythm group appeared to make a significantly greater improvement in single word reading between the pre-test and the delayed post-test than children receiving the traditional phonological awareness-based intervention. This was surprising, and illustrated the potential of speech rhythm training, showing that not only did the speech rhythm-based intervention result in equal gains to the phonological intervention in the short term, but it also resulted in larger gains than phonological training in the long term. This can again be linked back to the theory proposed in section 2.2. It is possible that training on the speech rhythm-based intervention enabled children to subsequently acquire phonological awareness and following this, develop skills in single word reading, leading to more successful reading performance in the long term. However, what was controversial was that there was no significant difference between the speech rhythm group and the semantic control group in their overall improvement in single word reading in the long term, suggesting that the semantic control intervention was equally successful for improving word reading ability in the long term as a speech rhythm-based intervention, or, alternatively, that the speech rhythm-based intervention was no better at improving word reading in the long term than a control intervention. In addition, there was no significant difference between the phonological awareness group and the semantic control group in their overall growth in reading performance, suggesting that the phonological awareness intervention was also no better than a control for improving word reading performance in the long term. An alternative explanation for this, which was also touched upon in Chapter 5.4, is that training on a phonological awareness-based intervention may in some way inhibit the growth of speech rhythm sensitivity, and this could in turn prevent reading performance from developing. When we look at the developments in speech rhythm sensitivity over time, we can observe that the speech rhythm group improved significantly more than both the phonological awareness group and the semantic control group in total speech rhythm sensitivity in the long term, whilst there was no significant difference between the phonological awareness group and semantic control group. This supports the theory by suggesting that training on phonological awareness does not develop speech rhythm sensitivity any more than a control intervention.

The final aim for this study was to determine whether the characteristics of children who benefited from exposure to the speech rhythm intervention differed from children who benefited from exposure to a traditional phonological awareness-based intervention. Results showed that there were no significant differences at the pre-test between children whose reading benefitted from the speech rhythm intervention and children whose reading benefitted from the phonological awareness intervention, suggesting that there are no characteristics which can pre-determine whether a child may respond better to either type of intervention. However, when we considered the children who did and the children who did not benefit from the speech rhythm-based intervention, results revealed that children whose reading benefitted from exposure to the speech rhythm-based intervention performed significantly higher on the block building task at the pre-test than children whose reading did not benefit from exposure to the speech rhythm-based intervention. In addition, children who benefitted from the speech rhythm intervention had significantly lower vocabulary at the pre-test than children who did not benefit from the speech rhythm intervention. This suggests that children who have low vocabulary and perform highly on the block building task at Time 1 may benefit from a speech rhythm-based intervention more than children with higher vocabulary and lower block building performance. However, as there were no other significant differences between children who did and children who did not benefit from exposure to the speech rhythm intervention it is difficult to draw valid conclusions from this.

6.4.1 Limitations and Future Directions

A weakness of this study lies in the fact that although the phonological awareness-based intervention had been altered from the intervention used in Study 1, the phonological awareness-based training materials used in this study were not directly related to the assessment tools used to measure phonological awareness at the pre- and post-tests, resulting in no significant differences between groups on their improvement in phonological awareness at any of the time points. Due to the fact that there was no evidence to support the effectiveness of the phonological awareness-based intervention employed in this study, it is therefore difficult to draw a valid conclusion as to whether the speech rhythm intervention was really as successful as traditional phonological based training methods for improving literacy skills.

In addition, a further weakness lies in the fact that there were two intakes for this study. Whilst initial analysis showed that there were no differences between the two intakes in terms of their literacy skills and data were therefore treated as one data set, the two intakes were exposed to the interventions at different points in their academic year. It is possible that this could have affected their response to the interventions, with consideration for external factors such as term time, school events and the child’s attitude to learning at different stages in the school year. Furthermore, due to low participant numbers, some children were trained in pairs rather than groups of three, and so although every effort was made to ensure that training was equal, some children may have had a different experience of the intervention to others. It was also not possible to administer the group ‘carpet time’ activities in this study due to the small participant numbers in each school at each intake, and so the children in this study did not receive the full intervention experience as children in Study 1 did.

It is suggested that future work in the area implements this type of intervention on a larger scale and at a single time point, although there was little control over this during the current research due to the time restrictions in place for this thesis. Further research should also ensure that the skills taught during the phonological-based intervention(s) are specifically related to the skills that are assessed at pre- and post-test.

One of the interesting findings from this study was that the improvement rates in literacy skills were not maintained once the interventions were terminated, and it has been suggested that continued training could be necessary to maintain such improvements. In response to this, it is suggested that further research in the area could implement a stop-start method, whereby children receive treatment for one course of intervention, followed by a cool-off period and then followed by a second course of intervention, in order to determine whether improvement rate falls again after the second phase. If this is the case, it would confirm the idea that struggling readers need continued treatment to maintain improvement rates post-intervention and would enable the intervention to be targeted in the most effective manner for the children involved.

6.5 Conclusions

Overall, results have shown that the speech rhythm-based intervention was successful for improving the speech rhythm sensitivity and single word reading performance of 7-8 year old children who had already received some formal reading tuition but who were falling behind the expected level for a child in their age group on a standardised reading test. Results have shown that the speech rhythm-based intervention has the ability to influence both the speech rhythm sensitivity and reading performance of struggling readers beyond the level of a semantic control intervention in the short term. In addition, results have shown that a speech rhythm based intervention can be more effective than a traditional phonological approach for improving word reading performance in the long term. However, the fact that the phonological awareness-based intervention employed in this study did not result in any greater reading performance or phonological awareness than the control intervention suggests that it was not as effective as we may have hoped. It is concluded that training on the speech rhythm-based intervention can improve both speech rhythm sensitivity and word reading ability, but as with study 1, we are cautious with respect to our interpretation of results in relation to the phonological awareness-based intervention and further research is therefore warranted. Furthermore, whilst the study has its weaknesses, it does add to growing literature in the area by providing an insight into the impact that various methods of tuition can have on the development of reading skills in 7-8 year old struggling readers.

Chapter 7: General Discussion

This thesis set out to develop a set of speech rhythm-based training materials suitable for use with both 4-5 year old beginning readers, and 7-8 year-old children who had already received some formal reading tuition but who failed to meet the level expected for a child in their age group on a standardised reading assessment. This thesis aimed to evaluate the effectiveness of the speech rhythm-based intervention for developing the speech rhythm sensitivity and reading skills of children in both groups. In each case, the new speech rhythm-based intervention was compared to both a traditional phonological-based training method and a control group, with the final aim being to identify whether the characteristics of children whose reading skills improved as a consequence of exposure to the speech rhythm-based intervention differed from those of children whose reading skills improved as a result of phonological awareness training.

A growing literature has demonstrated the relationship between speech rhythm sensitivity and reading development. This literature has linked speech rhythm sensitivity to different reading skills, namely segmental phonological awareness (e.g. see Wood, 2006), reading acquisition (e.g. see Goswami et al, 2002; Holliman et al, 2010a; 2010b; Schwanenflugel et al, 2004; Whalley and Hansen, 2006), reading comprehension (e.g. see Whalley and Hansen, 2006), and also reading difficulties (e.g. de Bree et al, 2006; Goswami et al, 2002; Thomson et al, 2006; Wood and Terrell, 1998). Such research evidence illustrates that an individual's level of speech rhythm sensitivity is linked to their reading performance, suggesting that if we can improve their sensitivity to speech rhythm, then their level of reading performance may also improve. Indeed, Holliman et al (2010b) claimed that a study of this kind would be timely. However, to date there has been little reference in the literature to interventions which have targeted speech rhythm as a possible way of enhancing reading performance. A study by Samuelsson (2011) aimed to administer a speech rhythm-based training programme to a single participant to determine whether it was possible to enhance speech rhythm sensitivity through formal training. Results showed that this was possible, and that the speech rhythm training resulted in a higher level of speech rhythm sensitivity at the post-test at the word, phrase and discourse level. However, Samuelsson did not relate the boy’s performance on speech rhythm measures to his reading performance. A small number of studies (see Thomson et al, 2013; Bhide et al, 2013) have since found evidence that training on a speech rhythm-based intervention has the ability to influence literacy skills. Thomson et al (2013), in particular, found that children who received training on a rhythmic-based intervention made significant gains in spelling, word- and non-word reading, phonological awareness and rise-time discrimination. Bhide et al (2013) additionally found that rhythmic-based training resulted in gains in reading and phonological awareness. Both of these studies compared the effects of rhythmic-based training to a phonological-based comparison intervention group, although only Thomson et al included a comparison with an untreated control group. In addition, both of these studies were conducted with children who had already been in receipt of phonological training through their general schooling, with Thomson et al focusing on children with a mean age of 9 years and Bhide et al concentrating on 6-7 year olds. Furthermore, both of these studies focused on children who were defined as either poor readers (Bhide et al, 2013) or dyslexic (Thomson et al, 2013). This thesis therefore aimed to address under-researched areas by implementing the speech rhythm-based reading intervention in both beginning readers (aged 4-5 years) and older struggling readers (defined as those who performed at six months or more below their chronological age on a standardised reading assessment), in order to determine whether it is better to intervene before the onset of formal reading tuition, or once children are already in receipt of reading tuition. This thesis also aimed to address weaknesses in these existing rhythmic intervention studies by comparing the impact of the speech rhythm intervention to both a phonological-based intervention and a non-literacy control intervention in both groups of children.

In order to determine whether speech rhythm training is effective in developing speech rhythm sensitivity and enhancing word reading ability, the thesis would need to establish that the speech rhythm sensitivity of children receiving training on the speech rhythm intervention improved between pre- and post-test assessments, and that this improvement is greater than any improvement made by children receiving a control intervention programme. The thesis would also need to establish that the speech rhythm based intervention results in gains in word reading performance that are greater than gains made by children receiving the control intervention.

The unique contribution of this thesis will now be considered in relation to reading research and the field of reading development. The two main studies in this thesis will be discussed in turn in relation to their individual contributions, and the development of the work involved in this thesis will also be considered.

7.1 Contribution of this Thesis

This section will consider the unique contribution that this thesis makes to the field of reading development. The two main studies included in this thesis will be reviewed in turn, in relation to the contribution that they make to knowledge in this area.

It was argued in Chapter 2 that although a great deal of work has examined the potential of existing phonological-based methods in supporting early literacy skills, there is evidence that also shows that this type of reading tuition is not effective for all children, in particular those with reading difficulties (see Torgesen, 2000). It was also argued that a large body of evidence has supported the link between speech rhythm sensitivity and various reading skills, supporting the importance of speech rhythm sensitivity in reading development. Finally, it was argued that intervention studies focusing on training speech rhythm sensitivity as a possible way of enhancing reading performance remain very limited; and those which do exist direct their training primarily at poor readers who have already received some formal tuition. It was therefore claimed that no study to date had trained beginning readers on speech rhythm sensitivity; no study had compared the effects of a speech rhythm-based intervention to a phonological-based training programme *and* a treated control group; and no study had compared the effects of a speech rhythm-based intervention in beginning readers to its effects in struggling readers.

7.1.1 Study 1

The first study in this thesis investigated the potential of the speech rhythm-based intervention to improve the speech rhythm sensitivity and word reading abilities of children who had not yet received any formal reading tuition using a sample of seventy-three English-speaking children aged 4-5 years. To assess children's literacy skills at the pre-test (Time 1), post-test (Time 2) and delayed post-test (Time 3), a number of standardised assessments were administered to measure children's single word reading ability, phonological awareness and receptive vocabulary. To assess speech rhythm sensitivity, a task was devised using a similar format to the speech rhythm-based intervention materials outlined in Chapter 3, with a separate pool of items being created for use in the assessment weeks.

There were 3 main research questions in study 1. Firstly, the study aimed to determine whether training on the speech rhythm-based intervention could benefit children's reading development. Despite previous studies demonstrating the capability of rhythmic-based training to enhance literacy performance in poor readers (see Bhide et al, 2013; Thomson et al, 2013), it was not yet established whether training on this kind of intervention could enhance the word reading abilities of beginning readers who had not yet received any formal reading tuition. Research looking into the relationship between speech rhythm sensitivity and reading development has already demonstrated that there is a substantial link between speech rhythm sensitivity and the acquisition of reading (see Goswami et al, 2002; Holliman et al, 2010a; 2010b; Schwanenflugel et al, 2004; Whalley and Hansen, 2006). However, it was not yet known whether improving speech rhythm sensitivity through training would have an effect on the reading acquisition process. In addition, research has shown that speech rhythm sensitivity is related to literacy skills in beginning readers (e.g. see Wood, 2006), but no study to date had looked into the effects of speech rhythm training on the reading performance of children in this age group.

It was found that children who received training on the speech rhythm-based intervention showed significantly greater improvement in their speech rhythm sensitivity than children who received either the phonological awareness-based intervention or the maths-based control intervention, illustrating that the speech rhythm-based training materials were successful in enhancing speech rhythm sensitivity to a level beyond that which would develop without specific training. This finding was expected as children were directly trained on elements of speech rhythm sensitivity. What was surprising, however, was that there were different results for each of the three elements of speech rhythm. No significant difference was found between groups on their improvement in sensitivity to stress or timing, but there was a significant difference between groups on their improvement in sensitivity to intonation. These findings have been discussed in relation to the idea of speech rhythm being a unitary construct, and this will be revisited later.

Findings also illustrated that children who received the speech rhythm intervention showed a significantly greater improvement in their single word reading ability than children in the control group, supporting the hypothesis that the speech rhythm-based intervention would improve word reading more than a control. This is not surprising as mathematical training would not be expected to improve literacy skills. In response to the research question, this shows that training on a speech rhythm-based intervention can benefit word reading performance to a level beyond that which would occur without such training.

Secondly, study one aimed to investigate whether such speech rhythm-based training activities could result in gains in reading that were equivalent to those observed by a more traditional phonological-based intervention programme. Although two studies currently exist which compare the effects of speech rhythm training to the effects of traditional phonological-based methods (see Bhide et al, 2013; Thomson et al, 2013), none have looked at this comparison in pre-readers. Furthermore, existing studies looking at this comparison have focused primarily on older children defined as poor readers. More research in this area was therefore needed to determine whether speech rhythm training can be as effective as traditional methods for improving word reading ability. Findings from Study 1 indicated that there was no significant difference between children who received the speech rhythm-based intervention and children who received the phonological awareness intervention in terms of their improvement in single word reading between Time 1 and Time 2. This lack of significant difference between the speech rhythm group and the phonological awareness group illustrates that speech rhythm-based training can be just as effective as traditional phonological awareness-based training methods for improving word reading performance. However, the lack of significant difference between children receiving the phonological awareness intervention and children who received the maths-based control intervention was surprising given that phonological-based training methods have been developed and administered in schools over many years and have been shown to be effective for improving literacy skills. This supports the idea that the phonological awareness intervention employed in this study may not have been as effective as anticipated. It has been discussed that the lack of significant difference between groups on their improvement in phonological awareness adds to this concern, which leads to caution with respect to the interpretation of results in relation to phonological awareness-based training. For this reason, the phonological-based intervention used as a comparison was altered for the second study included in this thesis, and this decision will be revisited later in the discussion of Study 2.

In addition to the findings discussed above, a comparison between the delayed post-test at time 3 and the pre-test at time 1 allowed determination of whether the intervention(s) remained as effective for improving literacy skills in the long term. Such comparisons revealed that there was a significant difference between the speech rhythm group and the maths-based control group in terms of their improvement in single word reading between Time 1 and Time 3, illustrating that the speech rhythm based intervention is more effective than a control intervention for improving word reading performance in the long term. Furthermore, there was no significant difference between the speech rhythm group and the phonological awareness group, illustrating that the speech rhythm -based intervention is just as effective as a phonological approach for improving word reading in the long term, and does result in long term gains in reading that are equivalent to those of children receiving traditional phonological awareness-based training.

The third and final research question for study one was concerned with whether the observable characteristics of children who benefit from exposure to a speech rhythm-based training programme differed from those who benefit from exposure to a traditional phonological approach to reading tuition. Due to the limited existing literature into speech rhythm training, there is a lack of evidence pointing towards identifying the characteristics which make is possible for children to benefit from exposure to this new type of tuition. It is important to identify the characteristics of children who will benefit from this type of programme so that intervention can be targeted effectively and so that children will get the most benefit out of reading tuition. The children who benefited from exposure to the speech rhythm based intervention and showed an improvement in their single word reading performance between the pre-test at time 1 and post-test at time 2 were compared to children who made an improvement in their word reading performance as a result of exposure to the traditional phonological-based intervention. No significant differences were found between the pre-test characteristics of children who benefitted from the speech rhythm-based intervention and the children who benefitted from the phonological-based intervention, suggesting that there are no characteristics which may pre-determine a child's response to a specific type of intervention and that it is not possible to distinguish between children who will benefit from each type of intervention before children begin formal reading tuition.

7.1.1.1 Outstanding Questions

Outstanding questions from study one include the question over whether the speech rhythm intervention was really training children's speech rhythm sensitivity, as there was no established or standardised measure of speech rhythm sensitivity that was administered alongside the assessment that was formed for the study. Therefore, it is difficult to determine whether the children's individual levels of speech rhythm sensitivity as assessed by the measure used in this study would correlate with their level of speech rhythm sensitivity as measured by a more established existing measure. Including an additional measure of speech rhythm sensitivity would help to inform the reliability of the measure for assessing speech rhythm sensitivity. In addition, it is not possible to establish whether an individual’s level of reading comprehension can be influenced by speech rhythm sensitivity training, and this is something that was then incorporated into Study 2. Furthermore, whilst the maths-based intervention provided some form of educational benefit to children in the control group, it was obvious that this control intervention would not provide skills linked to reading. It is therefore not known from study one whether the speech rhythm intervention could outperform a literacy-based control intervention. This issue was also addressed in the second study in this thesis. Thirdly, there were some issues with the phonological based intervention in that the phonological intervention materials employed in Study 1 did not appear to result in gains in phonological awareness, which was surprising given that children in the phonological group were trained on these skills. It was difficult however to choose an intervention that was suitable for such young children as it is not until formal schooling that children begin learning to read through such phonological methods. This could have been one of the reasons why children did not respond to this intervention in the way we would expect and could have resulted in the lack of improvement in phonological awareness that we did not see in the results. Study 2 was to be aimed at improving the word reading abilities of struggling children in year 3 (those aged 7-8 years), but these children would have a much younger reading age. As the children in study 1 did not respond to the phonological based materials that were employed in the way they were expected to, the decision was made to employ materials from a different, more supported phonological-based intervention for Study 2.

7.1.2 Study 2

Study two investigated the potential of the speech rhythm-based intervention to enhance the speech rhythm sensitivity and word reading ability of children who had already received some formal reading tuition but who failed to meet the level expected for a child in their age group on a standardised reading assessment. All year 3 children at participating schools were assessed on a standardised reading measure in order to determine a reading age for each child in the year group. Children who achieved a reading age of six months or more below their chronological age were selected for participation. Forty-nine children took part in the study, all aged between 7 and 8 years. To assess the literacy skills of participants at the pre-test (Time 1), post-test (Time 2) and delayed post-test (Time 3), standardised assessments were administered to measure the children's single word reading, phonological awareness, reading comprehension and general intelligence. Speech rhythm sensitivity was measured using an assessment similar to the speech rhythm intervention materials, but with a separate pool of items for the assessment weeks as in Study 1. As in Study 1, participating children were randomly allocated to receive either the speech rhythm-based intervention, a traditional phonological awareness-based intervention, or a control. This time, the control intervention was based on semantics, teaching the children about vocabulary, word meanings, etc. Further details of this intervention are provided in Chapter 4 and in Appendix 8. The decision was made to alter the control intervention for study 2 because it was obvious in study 1 that the maths-based control did not have any links to literacy skills. For Study 2, the thesis aimed to employ an intervention that was still related to literacy, but did not have any direct links to reading skills such as decoding, etc, and therefore this intervention did not include any phonemic training and did not include the use of written words so that there was no connection between print and word.

There were 3 main research questions for study 2. The first research question was concerned with whether training on the speech rhythm-based intervention could enhance the word reading abilities of children aged 7-8 years who performed below the expected level on a standardised reading test. Existing research has supported the idea that speech rhythm sensitivity is related to reading performance in poor-reading children. For example, de Bree et al (2006) found that children at risk of reading difficulties performed below their chronological age-matched controls when imitating stress patterns, whilst Goswami et al (2006) found evidence that those with dyslexia were significantly less sensitive to speech rhythm than their normally developing peers. In addition, evidence has also shown support for the idea that this link with reading difficulties continues into adulthood. Thomson et al (2006), for example, found that undergraduate students with dyslexia performed significantly worse than controls on speech rhythm sensitivity. Such research leads us to question whether training children who experience difficulties in reading on speech rhythm sensitivity could have an effect on their reading performance.

Research by Thomson et al (2013) has previously shown that training dyslexic children of this age group on a rhythmic based intervention resulted in significant gains in spelling, word- and non-word reading, phonological awareness and rise-time discrimination that were equivalent to those gains observed in children receiving a phonetic-based control intervention. Bhide et al (2013) also found that training poor readers in this age group on a rhythmic based intervention resulted in gains in reading and phonological awareness which again were equivalent to those observed in children receiving phonological-based training. However, whilst Thomson et al did include a comparison with an untreated control group, no study to date had compared the effects of a rhythmic based intervention to both a phonological-based intervention as well as a treated control group, and so it remained unknown as to whether a rhythmic based intervention could improve the word reading abilities of struggling readers significantly more than a control intervention.

All children who took part in Study 2 were those who had already shown a low level of reading attainment and had achieved a reading age of 6 months or more below their chronological age. It was found that children who were exposed to the speech rhythm-based intervention showed gains in their reading performance between Time 1 and Time 2, and that the gain in the children who had received the speech rhythm-based intervention was significantly greater than gains observed in the reading of children who had been exposed to the control (semantic-based) intervention, thus supporting the idea that speech rhythm training is more effective than a control for enhancing word reading performance.

Secondly, study two aimed to determine whether any gains in reading that were observed as a result of exposure to the speech rhythm-based intervention were equivalent to those observed by more traditional phonological methods of tuition. The children in the speech rhythm group were therefore compared to children receiving the traditional phonological awareness-based intervention in terms of their improvement in reading between the pre- and post-test assessments (Time 1 and Time 2, respectively). Similarly to the results of Study 1, there was no significant difference between children who received the speech rhythm based intervention and children who received training on the phonological awareness based intervention in terms of their improvement in reading performance between Time 1 and Time 2, indicating that training on a speech rhythm-based intervention can be just as effective as traditional phonological-based methods for enhancing the reading performance of struggling readers. However, what was surprising was that there was no significant difference in reading improvement between the phonological awareness group and the semantic control group. It was suggested in section 6.4 that the phonological awareness-based intervention employed in this study may not have been as effective as we would expect for improving word reading performance, similarly to that employed in study 1. However, this result does make sense in relation to the theory set out in section 2.2, because the children in this study had already received some formal reading tuition in school which had taught them through phonological awareness-based methods. If these children had responded to this training in the way we would expect them to, then they would not be struggling readers in the first place, and so giving them more of what they have already received (and what they clearly have not responded to) will have little added benefit.

Thirdly, study 2 aimed to determine whether children who benefited from exposure to the speech rhythm based intervention differed in their characteristics to children whose reading benefited from exposure to the traditional phonological awareness-based intervention. Children who made a significant gain in their reading performance in each group were isolated for further analysis and it was found that children who benefited from exposure to the speech rhythm based intervention tended to have lower single word reading abilities at Time 1 (pre-test) than children who benefited from exposure to the phonological awareness based intervention. In addition, children who benefitted from exposure to the phonological awareness based intervention tended to perform better on the phonological awareness measures at Time 1 than children who benefited from exposure to the speech rhythm-based intervention. What this means is that children who have poor word reading *and* phonological awareness tend to benefit more from exposure to the speech rhythm intervention, whereas children who have poor word reading but average phonological awareness tend to benefit more from additional phonological awareness training. This makes sense because we must have some concept of phonological awareness to understand the tasks involved in phonological awareness-based lessons. If the child does not have these skills then it makes sense to target a different skill, i.e. speech rhythm.

7.1.3 Theoretical Links

These findings can be explained in relation to the theory in section 2.2, where it was proposed that speech rhythm sensitivity, or sensitivity to the suprasegmental elements of speech, is a pre-requisite and underlying skill necessary for the development of segmental phonological awareness. What is observed in Study 2 is that children who have poor segmental phonological awareness as well as poor reading ability will respond successfully to speech rhythm training. If we look at the theory, illustrated again in figure 7.1, it is proposed that children need an awareness of segmental phonology to be able to understand and respond to phonological awareness training, but they also need an awareness of speech rhythm in order to be aware of these segmental elements of phonology in the first place. If they do not already have an awareness of speech rhythm, then they will not gain anything from phonological awareness training and therefore struggle to grasp the skills necessary to become a successful reader. It is therefore proposed, and illustrated in figure 7.1, that children who have already received some reading tuition in class should be allocated to an intervention through answering a few basic questions. Firstly, at step 1, children should be assessed on their existing reading performance. If this is good, no extra tuition is needed. If this is poor, we should move up to a higher level skill on the model and assess their phonological awareness. As these children will already have been in receipt of some phonological awareness-based training in school, it is assumed that if they are struggling to read then they have not responded to this training and have not gained an adequate level of segmental phonological awareness in order to become a successful reader. If their segmental phonological awareness is good, these children should be able to respond to phonological awareness training and may be struggling to grasp the concepts for different reasons, so these children should benefit from additional phonological awareness-based training. If their phonological awareness is poor, however, it is suggested that this is because they lack the suprasegmental phonological awareness necessary to grasp the concepts for segmental phonological awareness. It is suggested, therefore, that we move up the ladder again to a higher level skill, this time suprasegmental phonological awareness, and administer speech rhythm training.

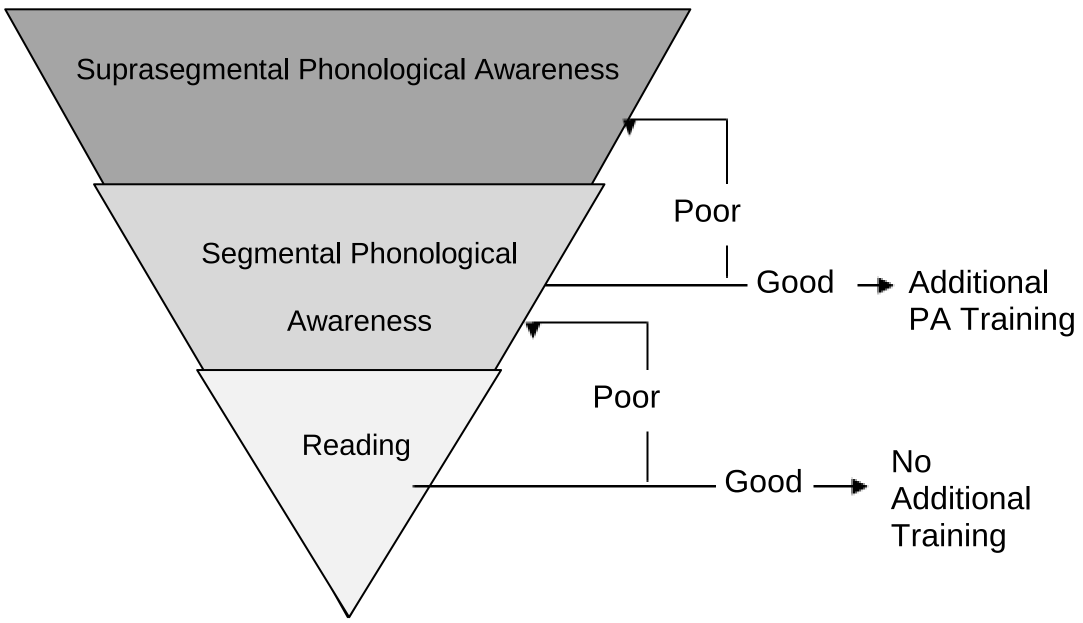

Figure 7.1 Outline of the theory and proposal for training methods

We can also use this theory to explain the fact that the children in study 1 who received the speech rhythm-based intervention tended to improve more on average than the other groups on their phonological awareness. It is important to bear in mind that the phonological awareness-based intervention was not deemed to be effective at training phonological awareness in either study, and so caution must be taken in comparing the effects of the speech rhythm intervention to the effects of the phonological awareness intervention in each case. In relation to the theory outlined in Chapter 2 and in reiterated in Figure 7.1, if the children in Study 1 had not yet gained an adequate level of speech rhythm sensitivity, then they may not have been able to gain segmental phonological awareness and subsequently gain reading skills. Therefore, training these children on speech rhythm sensitivity may have also allowed them to gain phonological awareness and thus influenced their reading. This supports the idea that speech rhythm sensitivity may be directly related to reading and suggests that we may be able to bypass phonological awareness training through speech rhythm training. However, it is important to note thatthe children in study 1 began formal reading tuition in class around the same time as the intervention study began, and so participants were also receiving some phonological-based training at the same time as the interventions were being administered for this study. Another possible explanation is that training beginning readers on speech rhythm sensitivity gave them the ability to respond to their phonological-based training that they were then receiving in class and to understand the principles necessary to succeed in gaining segmental phonological awareness, thus resulting in a higher gain in phonological awareness in the speech rhythm group than the other two intervention groups.

The results of both of the studies involved in this thesis inform the classic segmentally-oriented theories of dyslexia by suggesting that the phonological deficit observed in children with reading difficulties could actually be a combination of difficulties in both suprasegmental and segmental phonology. Indeed, Swan and Goswami (1997) presented evidence that the phonological awareness deficits in dyslexic children appeared to stem from problems in the encoding and/or retrieval of phonological representations. In relation to the theory in Chapter 2.2 and reiterated in Figure 7.1, the results of these studies suggest that the retrieval of such segmental phonological representations could be influenced by the child’s level of speech rhythm sensitivity, supporting the idea that deficits occur in both segmental and suprasegmental phonology. Extensive research into the relationship between phonological awareness and reading difficulties (discussed in Chapter 1) has led to the widespread assumption that dyslexia is caused by a core phonological deficit. Uppstad and Tonnessen (2007) criticized this view, claiming that a definition of dyslexia should not be based on causes because this limits the search for other contributing factors, supporting the view that suprasegmental phonology may also contribute. The growing literature supporting the relationship between speech rhythm sensitivity and reading difficulties only strengthens this view further (see de Bree et al, 2006; Goswami et al, 2002; Thomson et al, 2006; Wood and Terrell, 1998). Indeed, Protopapas et al (2006) argued that cognitive models of reading must be extended to account for the growing literature supporting the role of rhythmic elements in reading, particularly focusing on stress awareness. This leads to the suggestion that theories of dyslexia and other reading difficulties should be amended to account for the role of suprasegmental phonology as well as segmental phonology.

7.1.4 Speech Rhythm as a Unitary Construct?

As well as contributing to existing theories and supporting the theory set out in Chapter 2.2, the studies involved in this thesis also make a contribution to literature in the area in relation to the question over whether speech rhythm can be labeled as a unitary construct. This question was raised in Chapter 2 where evidence was discussed which showed that the different elements of speech rhythm are related to reading in different ways. For example, whilst stress has been shown to be related to phonemic and rhyme awareness (see Holliman et al, 2008), intonation has been related to decoding and reading fluency (see Miller and Schwanenflugel, 2008; Schwanenflugel et al, 2004). Holliman et al (2014) discussed this evidence in depth, and developed a measure which assessed the different components of speech rhythm at different levels. Indeed, findings showed that the model was able to distinguish between the different elements and levels of speech rhythm sensitivity, adding to a growing literature in this area.

The rhythmic-based intervention outlined in chapter 4 and implemented in the studies involved in this thesis is the first of its kind to address the issue of speech rhythm as a unitary construct. Whilst other rhythmic-based interventions exist in the literature (see Bhide et al, 2013; Thomson et al, 2013), none have trained the different components of speech rhythm separately, highlighting the uniqueness of the work in this thesis.

The findings from the studies involved in this thesis add to this argument by suggesting that the different components of speech rhythm are not necessarily related to each other. The correlation analyses conducted on the data for both studies show that there was no significant correlation between any of the three components of speech rhythm either at the pre-test or the post-test for any of the groups. This highlights that a high score on one element does not necessarily indicate a high score on the other elements, and supports the idea that each component makes an individual contribution to overall speech rhythm sensitivity. These findings also support the decision to measure and train each of the components of speech rhythm individually, and further confirm the uniqueness of the intervention. This support for the idea that speech rhythm cannot be labeled as a unitary construct also criticises previous research which has had a tendency to measure speech rhythm within a single assessment (i.e. a stress awareness task) and assume an overall measure of prosody (e.g. see Wood, 2006, Wood and Terrell, 1998).

7.1.5 Summary

Overall, the studies involved in this thesis make a huge contribution to existing literature in the area of reading development. Whilst a small number of interventions exist which aim to train speech rhythm sensitivity as a possible way of enhancing reading development, the work involved in this thesis addresses gaps in existing literature by administering the intervention to both beginning readers and older struggling readers. In addition, comparisons are made to both a traditional phonological approach and a treated control group in both studies. The findings of these studies offer new evidence supporting the importance of speech rhythm sensitivity as a mediator in the relationship between phonological awareness and reading, and supporting the theoretical standpoint set out at the beginning of this thesis. Not only do these studies show that speech rhythm training can be effective for improving the speech rhythm sensitivity of both beginning readers and older struggling readers, but they also show that such training can enhance the word reading abilities of both groups of children significantly more than a control intervention. Furthermore, we can also consider the contribution this thesis makes to the idea of speech rhythm being a unitary construct. This thesis contributes to knowledge in this area by showing that the three individual components of speech rhythm measured in the pre- and post-test assessments were not correlated with one another at any level, in any group, or in either study. This offers support for the notion that speech rhythm should not be seen as a unitary construct and suggests that we cannot simply measure one component and assume an overall measure of speech rhythm as has previously been assumed. We therefore suggest that any study measuring stress sensitivity alone refers to this as stress sensitivity and not as speech rhythm or prosodic sensitivity as this gives a false interpretation of what the study involves. This finding supports the nature of the intervention outlined in Chapter 4, in terms of training the three elements of speech rhythm separately, and shows that the intervention designed, created and implemented as part of this thesis has merit in the fact that it separates these three components. The intervention will now be evaluated further in relation to the criteria set out in Chapter 3.

7.2 Evaluating the Intervention

This section will evaluate the speech rhythm-based intervention designed as part of this thesis and outlined in Chapter 4. The intervention comprised of three tasks, assessing and training the children's ability to detect the three main components of speech rhythm, namely stress, intonation and timing. Two experiments are reported in Chapters 5 and 6 of this thesis, and the unique contributions of these studies and their findings have been discussed above in section 7.1. There were a number of issues to consider when creating this intervention, and one was the fact that there were no set criteria for what an intervention should look like. The process of writing the intervention therefore began by compiling existing recommendations from organisations, researchers and educators, which lead to the development of a list of 12 criteria on which an intervention could be based. This process and the criteria are detailed in Chapter 3 of this thesis, and this section will evaluate the speech rhythm-based intervention, outlined in Chapter 4, in relation to these 12 criteria.

The first point to consider is that all children should be screened on a simple standardised assessment. In study 1, we wanted to assess the ability of the intervention for improving the reading skills of all children, and so there was no screening before the selection of participants. However, once participating children had been recruited, all children were assessed on their single word reading and various literacy skills before the intervention was implemented in order to establish baseline scores for each of the assessed skills. In study 2, the aim was to target only those children who were falling behind the expected level for a child in their age group in terms of their reading performance, and because of this, all children were screened on the Diagnostic Test of Word Reading Processes (DTWRP) prior to the selection of participants.

Secondly, the criteria outlined in Chapter 3 state that we should closely monitor the progress of children at risk of developing difficulties who are not yet in the intervention group. Within the scope of the studies involved in this thesis, it was not possible for us to monitor the progress of children who were not receiving the intervention for ethical reasons. In the first study, parents who wanted their children to take part in the study were required to return the consent form to confirm that they wanted their child to take part. It would therefore have been unethical for us to assess children whose parents had not consented for them to take part. In the second study, only the children who were falling behind with their reading were selected for participation, and only the parents of these children received a consent letter. An opt-out procedure was used for the second study because it was assumed that parents would be happy for their children to take part in something that would benefit their reading performance. Any child whose parents returned the opt-out form was not included in the study. It would therefore have been unethical for us to collect data from any child who was not participating in the studies. However, if the intervention was to be implemented in the classroom on a wider scale, it would be easy for progress to be monitored by teachers.

Thirdly, the criteria state that a target group for the intervention should be selected based on the outcome of standardised assessments. This was true for the second study where only those children who performed below the level we would expect on the DTWRP were selected as potential participants. However, in the first study, the aim was to determine the effectiveness of the intervention for improving the word reading abilities of beginning readers and so there was no criteria for inclusion other than the fact children were in reception classes at participating schools and their parents had consented to their participation.

The criteria in Chapter 3 also state that children should be randomly allocated to intervention groups within intervention research studies. Random allocation of participants occurred in both studies involved in this thesis, where a random number generator was used to allocate participants to either the speech rhythm intervention (1), a traditional phonological-based intervention (2), or a control intervention (3) in each study. This allowed comparison with both an established control (the phonological approach) and a non-reading control (the maths intervention in Study 1 and the semantic intervention in Study 2), which also links to the criteria point on monitoring progress in comparison to control groups. Progress was monitored by re-assessing each of the literacy skills that were assessed at Time 1 after the intervention at Time 2 and again in a delayed post-test at Time 3, and all intervention groups were compared on each of these skills at each of the three time points.

We should also aim to ensure that all activities are integral into the national curriculum and that they are compatible with classroom activities. As the intervention trained skills that children use on a day-to-day basis within their interpretation of spoken language, it is assumed that the materials included in the intervention would compliment general language skills as well as reading performance.

If children are to benefit from the intervention it is also important that they enjoy and understand what they are learning, and so creating a tightly structured timetable of activities is also highlighted as being of importance. The speech rhythm intervention was designed to be repetitive because of the short attention span of the young children who were taking part, so the same three activities were completed each week, training each of the components of speech rhythm. However, the items that were administered each week were administered in line with a structured timetable which is presented in appendix 1.

The criteria also claim that goals should be set for each pupil at the start of the intervention, in order to give the children something to work towards. As the same activities were completed each week and there were only 5 items in each task, the goal was for perfection, and the majority of participants receiving the speech rhythm-based intervention achieved full marks by the end of the intervention period.

We should also monitor progress throughout the intervention period in order to keep track of how the children are improving. In both of the studies involved in this thesis, the children were scored each week on their responses to the three tasks involved in the intervention. As the intervention followed a similar format to the speech rhythm assessment used to assess speech rhythm sensitivity at the pre- and post-test, there was already a scoring system in place and children received a mark out of 15 each week for their speech rhythm sensitivity. This enabled us to map the children's progress week by week and to observe whether they were making a continued improvement in speech rhythm sensitivity throughout the course of the intervention.

The criteria further claim that we should ensure that the intervention is adaptable for individual needs. The materials used in the speech rhythm intervention are very basic, and although children are encouraged to repeat what they hear and to practice using different tonal patterns in speech, the intervention does not require any verbal contribution from the children and so it is also suitable for children with verbal difficulties. The intervention is also adaptable for children with social difficulties, where it could be administered one-to-one by a trained teaching assistant. Additional help can be given to those who need it, and additional items can be developed in the event that children need more practice on certain tasks.

If the intervention is to be administered in school, it is advised that we should aim for an intervention to last no longer than 1 school term. The intervention designed and administered in the studies in this thesis ran over a period of ten weeks so that it was possible to fit in the pre- and post-test assessments within the 12 week school term. The results show that the intervention was effective within this time scale, supporting the design.

Finally, the criteria state that intervention studies should report standardised scores by using standardised measures to monitor progress. The measures used to assess literacy skills at Time 1, Time 2 and Time 3 in both of the studies were all standardised measures, and so standardised scoring was available. However, due to the low ability of the children on the reading tasks in both of the studies, the majority of children who took part did not perform at the level necessary to calculate standardised scores for single word reading, and raw scores were used in the analyses for this reason.

Overall then, the new speech rhythm-based intervention appears to address the majority of the criteria set out in Chapter 3. Children were screened on standardised assessments, children were randomly allocated to treatment groups, the items were administered in line with a structured timetable for the intervention, progress was monitored throughout the intervention period, and standardised scores were reported wherever possible. The intervention is adaptable for individual needs, and can easily be incorporated into the classroom where is would be easier to adhere to the remaining criteria that were not achieved within the scope of the studies involved in this thesis.

7.3 Limitations and Future Directions

This thesis includes two studies which investigated the effectiveness of a speech rhythm-based reading intervention for improving the speech rhythm sensitivity and single word reading ability of both beginning readers and older struggling readers.

7.3.1 The Speech Rhythm-Based Intervention

The first step to conducting these studies was to design the speech rhythm-based intervention; a process that encountered many difficulties because this type of tuition is so under-researched. Although two studies have been published since (see Bhide et al, 2013; Thomson et al 2013), at the time the intervention was designed there were no studies in the literature which had administered rhythmic-based training as a way of enhancing literacy performance. As there were no existing foundations for the intervention to build on, various speech rhythm assessment tools were reviewed with a view to adapting some of these methods for use in speech rhythm training. With the growing concern over whether speech rhythm can be labeled as a unitary construct (see Holliman et al, 2013), the decision was made to assess and train each of the components of speech rhythm separately through three different tasks. Although this addressed the concerns in the literature by allowing the investigation of whether the three components of speech rhythm are related, splitting speech rhythm into three separate components did not allow for direct comparisons with the literature, where many studies have focused on and emphasised the importance of stress awareness. Despite this, however, the results of both studies in this thesis supported the idea that speech rhythm is not a unitary construct by illustrating that the three components of speech rhythm are not correlated with each other, and suggesting that we cannot simply measure one component and assume an overall measure of speech rhythm. Splitting speech rhythm into its individual elements in this way also raises issues as to whether each task involved in the intervention was purely training one skill, or whether these skills overlap in some way. Recall that the stress task required children to discriminate between strong and weak stress patterns in order to identify whether a word was pronounced correctly or incorrectly;

the intonation task required children to discriminate between rising and falling tonal patterns to identify a question or a statement; and the timing task required children to listen for pauses in speech to determine whether the audio sound represented one word or two words. However, when we consider the vocal representation of two words in comparison to one word, we can observe a shift in stress pattern. For example, where the word “breadstick” has a stressed first syllable, saying “bread” followed by “stick” results in both words being stressed.

7.3.2 Assessments of Literacy Skills

Together with the intervention materials, numerous measures of literacy performance were also included in these studies. A speech rhythm sensitivity assessment was adapted from the intervention materials in order to determine whether training resulted in gains in speech rhythm sensitivity. Although the items that were administered in each of the assessment weeks differed from those administered during the intervention, the fact that the format of the speech rhythm sensitivity assessment was the same as the intervention raises the issue over whether the improvement in speech rhythm sensitivity observed in children who received the speech rhythm-based intervention was due to practice effects and familiarity with the tasks. An additional speech rhythm sensitivity assessment may have been useful to account for this issue, although using an assessment similar to the intervention did have benefits in that it allowed us to ensure that the intervention was successful in improving the skills it was training. This was something that we could not be confident with for the phonological awareness interventions, as the assessments of phonological awareness measured skills that were not specifically trained throughout the intervention period. This is something that needs to be considered in further research, where assessments and interventions should be carefully matched to enable valid conclusions to be drawn from the results.

Three interventions were implemented within both of the studies involved in this thesis, in order to compare the effects of the speech rhythm-based intervention with both a traditional phonological awareness-based intervention and a control intervention in both groups of children. Whilst a small number of studies had previously been conducted involving the use of a speech rhythm-based intervention, none had administered such a training programme in children who had not yet received any formal reading tuition. This leads us to the first study, where results show that this type of training can be effective in young children. However, the children who took part in this first study were pre-readers, meaning that it was impossible to calculate standardised scores. Comparisons of reading performance and improvement in reading between the pre- and post-tests were therefore conducted with raw scores, which carries numerous limitations including the fact that scores are not as comparable. However, as the studies here were looking at the comparisons of each group’s improvement rates on each of the assessed skills between the pre- and post-tests, and not at the comparisons between groups at a single time point, the use of raw scores here did not cause a problem. A further issue with the data for Study 1 lies in the fact that a small number of children who took part in the study did have some reading ability even at the pre-test. However, when these children were removed and the analysis was re-run, results remained the same, and so the decision was made to keep these children in the dataset to maximize participant numbers. Other limitations of the first study lie in the comparison with a maths-based control. Whilst this did provide a baseline for comparison, and did provide the children in this group with some educational benefit, it was obvious that training on a maths-based intervention would not have effects on literacy. The decision was therefore made to alter the control intervention in Study 2, this time using a semantic-based control, which would still be language-based but was not specifically related to reading.

Another, uncontrollable limitation of the research involved in this thesis was that there was no control over the literacy tuition that the children involved in these studies were already receiving in school. Even though the children participating in Study 1 were in the initial stages of formal schooling and had not received any formal reading tuition at the time they began taking part in the study, these children were introduced to reading tuition (phonics lessons) at the same time the study began. As it would have been unethical to remove these children from their phonics lessons for the purpose of the research, all children involved in the research were also receiving some formal phonological awareness training as part of their general schooling at the same time they were receiving the interventions for the purpose of the research. However, as the children in the phonological awareness group were receiving additional phonological training to that which they were also receiving in class, all groups were equal in that they were all receiving the same amount of directed tuition throughout the intervention period. This was true for both of the studies involved in this thesis.

7.3.3 The Phonological Awareness Interventions

The two studies reported in this thesis had similar findings, showing that training on a speech rhythm-based intervention can result in significantly greater improvements in word reading than a control intervention in both groups of children. However, whilst the studies involved in this thesis offer promising results for the use of speech rhythm-based interventions as methods of literacy tuition, the comparison with phonological-based interventions can be deemed unreliable due to the fact that the phonological awareness training administered in both studies did not seem to be effective for improving either phonological awareness or single word reading ability, suggesting that this method of tuition had not worked in the way it was expected to in either study, despite altering the intervention for Study 2. Numerous explanations for this finding have been discussed in section 7.1, and further research is warranted to further investigate the effectiveness of speech rhythm training in comparison with, and also possibly in conjunction with, phonological awareness training.

7.3.4 Further Research

It is possible that the speech rhythm-based intervention could be implemented in conjunction with a traditional phonological approach to reading tuition, in comparison to the speech rhythm-based intervention alone and also in comparison to a traditional phonological awareness-based intervention alone. This would allow us to investigate whether phonological awareness-based training does in fact inhibit the growth of speech rhythm sensitivity as suggested by the results of the studies in this thesis. If this is the case, we would expect that children who are trained on both speech rhythm sensitivity and phonological awareness would not show any greater improvement in speech rhythm sensitivity than children who are trained on phonological awareness alone and receive no speech rhythm sensitivity training. However, at the same time, this method of research would also allow us to further investigate the theory proposed in section 2.2, as children who are trained on speech rhythm sensitivity will then be provided with the skills necessary to respond to phonological awareness training and subsequently acquire reading skills. If this is the case, we would expect a combination of speech rhythm and phonological awareness training to be the most effective approach for enhancing reading performance, because children in this group will be provided with both of the phonological skills necessary to become successful readers, rather than one or the other.

Another area of investigation would be to look at whether training in speech rhythm sensitivity first, followed by phonological awareness training, would be more effective for improving reading performance than training in phonological awareness first, followed by speech rhythm sensitivity training. In relation to the theory set out in Chapter 2.2, we would expect that children who receive speech rhythm sensitivity first would show greater improvements in reading because the theory claims that children need to establish speech rhythm sensitivity before they can adequately acquire segmental phonological awareness. To illustrate this, the children who took part in Study 2 had already received some phonological awareness training as part of their formal literacy tuition within their general schooling. However, these children had failed to acquire an adequate level of reading performance despite this training, and it is suggested that this may have been because they did not possess the level of suprasegmental phonological awareness (i.e. speech rhythm sensitivity) necessary to acquire segmental phonological awareness and subsequently to acquire reading ability. It is further suggested that if these children had been trained on speech rhythm sensitivity prior to phonological awareness training, they may have been more equipped to adequately acquire the phonological skills necessary to become successful readers. This is clearly an area that warrants further research, and is one which could have a huge impact on the future of literacy tuition with further research evidence to support it, and so a combined intervention study of this kind would be timely.

7.4 General Conclusions

Overall, the findings from the two studies involved in this thesis demonstrate that training on a speech rhythm-based intervention has the ability to improve both speech rhythm sensitivity and single word reading performance to a level beyond that of a control intervention, and can do so in both beginning readers and older struggling readers who have already received some formal reading tuition. However, due to the fact that the phonological awareness-based interventions administered in these studies were not as effective as anticipated, we are cautious with respect to our interpretation of results in relation to the phonological awareness-based intervention. The studies involved in this thesis have also provided a valuable insight into the composition of speech rhythm, and have added to the growing literature concerned with the debate over whether speech rhythm can be labeled as a unitary construct. This thesis also contributes a theory relating to the skills involved in developing successful reading skills, proposing that speech rhythm sensitivity may be a pre-requisite to segmental phonological awareness. The findings from the studies involved in this thesis support this theory, and also add to the literature on speech rhythm and reading by showing that not only can speech rhythm training be effective in children who struggle to learn to read, supporting Thomson et al (2013) and Bhide et al (2013), but this type of training can also be effective in children who have not yet received any formal reading tuition. However, this area of research remains very limited, and further research in line with the suggestions discussed above is therefore warranted.

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Appendix 1: Speech Rhythm Intervention

Administration Schedule

PRE-TEST ASSESSMENT

Stress Items	Intonation Items	Timing Items
Rabbit*	Raining outside?	Jellyfish (1)
Television	Monday today?	Foot Ball (2)
Computer*	Bedtime	Key Ring (2)
Trumpet*	Play on the Computer	Twenty one (1)
Finger	Bake gingerbread?	Sun Flower (2)

WEEK 1

Stress Items	Intonation Items	Timing Items
Sofa*	Play football?	Paintbrush (1)
Carrot	Daddy’s shoes	Pan Cake (2)
Camera*	Go shopping	Jacket potato (1)
Butterfly	Mummy’s coat?	Spiderman (1)
Chocolate*	Laughing?	Horse Shoe (2)

WEEK 2

Stress Items	Intonation Items	Timing Items
Football	Watch television	Doorbell (1)
Blanket*	Dinner time	Sand Castle (2)
Tomato	Your name?	Star Fish (2)
Crayons*	Go to the station?	Cowboy (1)
Dinner	Do some painting	Lip Stick (2)

WEEK 3

Stress Items	Intonation Items	Timing Items
Yoghurt*	Playtime?	Hair Brush (2)
Money*	Sunny outside	Apple pie (1)
Coffee	Sit on the sofa?	Breadstick (1)
Flower*	Draw a picture?	Greenhouse (1)
Dinosaur	Listen to the radio	Ear Ring (2)

WEEK 4

Stress Items	Intonation Items	Timing Items
Monkey	Read a book	Chocolate cake (1)
Parrot*	Shower	Bat Man (2)
Candle*	Breakfast	Butter Fly (2)
Paper	School bag?	Fish Fingers (2)
Potato	Build a rocket?	Ice cream (1)

WEEK 5

Stress Items	Intonation Items	Timing Items
Chicken*	Coffee?	Armchair (1)
Kettle	Play a game	Rain Bow (2)
Table*	Listen	Basketball (1)
Window	Washing up?	Sunglasses (1)
Pencil*	Push the trolley?	Tooth Brush (2)

WEEK 6

Stress Items	Intonation Items	Timing Items
Carrot*	Play football	Pancake (1)
Tomato*	Dinner time?	Starfish (1)
Flower	Sit on the sofa	Green House (2)
Potato*	School bag	Ice Cream (2)
Chicken	Listen?	Arm Chair (2)

WEEK 7

Stress Items	Intonation Items	Timing Items
Camera	Daddy’s shoes?	Jacket Potato (2)
Crayons	Your name	Cow Boy (2)
Dinosaur*	Draw a picture	Earring (1)
Monkey*	Read a book?	Chocolate Cake (2)
Kettle*	Coffee	Rainbow (1)

WEEK 8

Stress Items	Intonation Items	Timing Items
Butterfly*	Go shopping?	Spider Man (2)
Dinner*	Go to the station	Lipstick (1)
Yoghurt	Listen to the radio?	Hairbrush (1)
Parrot	Build a rocket	Batman (1)
Table	Play a game?	Basket Ball (2)

WEEK 9

Stress Items	Intonation Items	Timing Items
Chocolate	Mummy's coat	Horseshoe (1)
Football*	Do some painting?	Door Bell (2)
Money	Playtime	Apple Pie (2)
Candle	Shower?	Butterfly (1)
Window*	Push the trolley	Sunglasses (2)

WEEK 10

Stress Items	Intonation Items	Timing Items
Sofa	Laughing	Paint Brush (2)
Blanket	Watch television?	Sandcastle (1)
Coffee*	Sunny outside?	Bread Stick (2)
Paper*	Breakfast?	Fish fingers (1)
Pencil	Washing up	Toothbrush (1)

POST-TEST ASSESSMENT

Stress Items	Intonation Items	Timing Items
Teddy	Cup of tea?	Jelly Baby (2)
Vegetables*	Having fun?	Wheel Chair (2)
Cupcake	Look out the window	Blackbird (1)
Shower*	Eat your fruit	Cupcake (1)
Balloon*	Go swimming?	Ice Lolly (2)

DELAYED POST-TEST ASSESSMENT

Stress Items	Intonation Items	Timing Items
Rabbit	Raining outside	Football (1)
Computer	Monday today	Jelly Fish (2)
Television*	Play on the computer?	Keyring (1)
Trumpet	Bedtime?	Sunflower (1)
Finger*	Bake gingerbread	Twenty One (2)

Appendix 2: Stress Task Standardised Instructions

<u>Stress Task</u>

Equipment needed:

- Computer with USB slot.
- USB stick with verbal stimuli.
- 35 picture cards labelled "stress"
- Smiley face response cards labelled "stress"
- Score sheets detailing items to be administered each week.

Response: Scores recorded on paper by investigator.

<u>Instructions to participant</u>

1. *"Hello ___[name]___, would you like to play a word game with me?"*
   - If no, return child to class.
   - If yes, continue to step 2.

2. *"Ok, for this game I'm going to show you some pictures, and first of all I want you to tell me what the picture is of. Let's have a go."* Show child the first item (e.g. sofa) *"Can you tell me what this is a picture of?"*
   - If correct, say *"Yes that's right, well done. This is a sofa".*
   - If incorrect, or child is unsure, say *"Not quite, what else do you think it could be?"*
   - If still incorrect use the following prompts:
     - *"Have another go, it begins with a 'ss' sound"* [point to letter on picture card]
     - *"This is a picture of a… ss…"* [sound out first letter of the word whilst pointing at the picture]
     - *"Have a guess – it's a ss-oh-"* [sound out first two letters]
     - *"Ss-oh-ff…"* [sound out first three letters/sounds]
     - *"Ss-oh-ff-a… What is it?"* [sound out the word letter by letter whilst pointing at the picture. Then ask the child again, what the picture is]
     - *"This is a picture of a sofa…What is it?"*
   - When the child understands what the picture is, continue.

3. *"Ok, so we think this is a Sofa. Let's see what Janet thinks it is. For this bit we need to listen to some words on the computer"*

Show child the first item (sofa). Play the verbal stimuli for 'sofa'. *"Do you think Janet said the word in the same way to us, or a little bit different?"*

NOTE: Some verbal stimuli will have the correct stress placements; some will have their stress patterns reversed.

4. For Intervention weeks, children should respond using the picture cards, showing a happy face if the stress pattern is correct, and a sad face if the stress pattern is incorrect. For assessment weeks, DO NOT use response cards as children will be assessed individually. The child should tell you his/her answer verbally.

For assessment weeks, stop here.

For intervention weeks, continue to step 5.

5. If correct stress patterns in stimuli, say *"That's the same as what we thought it was"*

If reversed stress patterns in stimuli, say *"That's different to what we said"*

"Can you tell me where the strongest beat is in the word? Listen very carefully to ____ say the word, and tell me if the strongest beat is at the beginning or at the end. [replay stimuli]

- If correct, *"That's right well done, the strongest beat is at the beginning* **– SO*fa***"
- If incorrect, *"Listen again, is the strongest beat at the beginning 'SO' or at the end 'FA'?"*

6. *"Ok, let's try another one"*

Follow the same procedure for each of the five items each week.

<u>Notes:</u>

- Offer child feedback during the intervention weeks so that they can gain understanding of where they are going wrong.
- You can get the child to clap on the strongest beat of the word where the stress occurs.
- There are 35 picture cards, each with two corresponding audio stimuli (one with the correct stress pattern and one with the reversed stress pattern)
- Administer 5 items per session (10 sessions = 50 items, + 3 assessment sessions of 5 items each = 65 items in total)
- When using the materials for the assessment, DO NOT give feedback to students, and DO NOT use response cards. Response cards are used only for the intervention where there is more than one child being trained at one time, to ensure that each child can give their own response.

Appendix 3: Intonation Task Standardised Instructions

<u>Intonation Task</u>

Equipment needed:

- Computer with USB slot
- USB stick with verbal stimuli
- 35 Picture cards labelled "intonation"
- Question mark response cards labelled "intonation"

Response: Recorded on paper by the investigator.

<u>Instructions for participant</u>

1. *"Hello ___[name]____, would you like to play a word game with me?"*
   - If no, return to class.
   - If yes, continue to step 2.

2. *"Ok, for this game we are going to listen to some words and sentences and I want you to see if you can tell me whether Janet is asking you a question or whether she is telling you something. You have to listen very carefully to the sound that hervoice makes. Let's have a go."*

3. Show child the first item (raining outside) and play the matching stimuli. *"Do you think they were telling you it's raining outside, or were they asking you if it's raining outside?"*

For intervention weeks, children should use their response card to give their answer, raising the question mark above their head if they thought they heard a question, and placing it flat on the table if they thought they heard a statement (no rise in intonation). Explain this to the children before beginning each session.

- Record the child's first response on the scoring sheet by placing a tick in the correct box.

In assessment weeks, stop here.

In intervention weeks, continue to step 4 for feedback.

4. If their answer is correct, say *"Well done, that's right"*
   - If incorrect, say *"Are you sure? Listen again"*
   - If still incorrect say *"That one was actually (telling you/asking you)"*
   - If a question, say *"Can you hear how it goes up at the end?"*
   - If a statement, say *"Can you hear how the sound of the voice stays the same, but if it was a question her voice would go up at the end"*

<u>Notes:</u>

- Give child feedback so that they can understand where they are going wrong.
- There are 35 picture cards, each with two corresponding audio stimuli (one representing a question and one representing a statement)
- Administer 5 items per session (10 sessions = 50 items + 3 assessment sessions of 5 items each = 65 items in total).
- When using the materials for the assessment, DO NOT give feedback to students and DO NOT use response cards. Response cards are only used for the intervention weeks where more than one child is being trained at a time, to ensure that each individual can give their own response. In assessment weeks, the child should give you their answer verbally.

Appendix 4: Timing Task Standardised Instructions

Timing Task

Equipment needed:

- Computer with USB slot
- USB stick with verbal stimuli
- 35 Picture cards labelled “timing”
- Number response cards labelled “timing”

Response: Recorded on paper by the investigator

Instructions for participant

1. *“Hello ___[name]____, would you like to play a word game with me?”*
   - If no, return to class.
   - If yes, continue to step 2.

2. *“Ok, for this game we are going to listen to some words, and I want you to see if you can tell me whether Janet is saying two words, or whether she is saying one word. You have to listen very carefully to the pauses that she makes.”*

Show child the first item (paintbrush). *“Can you tell me what is in the pictures?”* Child should respond with *“paint”, “brush” and “paintbrush”* as you point to the pictures. If the child does not respond, give prompts as in the stress task.

When child understands what each of the pictures is, continue to step 3.

3. “*OK, now I am going to play the sound on the computer. See if you can tell me if Janet is saying one word* (point to paintbrush) *or two words* (point to paint and brush)”. Play the matching stimuli.

“Do you think she was saying one thing (point to paintbrush) *or two things* (point to paint and brush)?

- Child should respond with either “1” or “2”, using the response cards for intervention weeks. In assessment weeks, children should give their answer verbally. Record the child’s first response on the scoring sheet.

In assessment weeks, stop here.

In intervention weeks, continue to step 4.

4. If their answer is correct, say *“Well done, that’s right”*
   - If incorrect, say *“Are you sure? Listen again”*
   - If still incorrect say *“That one was actually this one”* (point to correct answer)

- *"Can you hear that there is a pause/isn't a pause between the two pictures.* (play stimuli again)

<u>Notes:</u>

- Give child feedback so that they can understand where they are going wrong.

- Administer 5 items per session (10 sessions = 50 items + 3 assessment sessions of 5 items each = 65 items in total).

- When using the materials for the assessment, DO NOT give feedback to students.

- When using the materials for the assessment, DO NOT give feedback to students, and DO NOT use response cards. Response cards are used only for the intervention where there is more than one child being trained at one time, to ensure that each child can give their own response.

Appendix 5: Phonological Awareness Intervention for Study 1

Activities taken from the 'Sound Linkage' intervention (Hatcher, 2000)

Week 1: 'Beginning', 'Middle' and 'End'
Section 1: Activities 1, 2, 3

Week 2: 'Syllabic Rhythm'
Section 2: Activities 2, 3, 4

Week 3: 'Syllables'
Section 2: Activities 5, 6, 7

Week 4: 'Phoneme Blending'
Section 3: Activities 1, 2, 3

Week 5: 'Phoneme Blending'
Section 3: Activities 6, 7

Week 6: 'Rhyming Words'
Section 4: Activities 1, 2, 3

Week 7: 'Rhyming Words'
Section 4: Activities 6, 7

Week 8: 'Identifying and Discriminating Phonemes'
Section 5: Activities 2, 4, 5

Week 9: 'Discriminating Phonemes'
Section 5: Activities 6, 10

Week 10: 'Segmenting Phonemes'
Section 6: Activities 1, 2, 3

Carpet Time activities: Phonic storybook reading from the Ruth Miskin series.

Appendix 6: Maths-based Control Intervention for Study 1

Activities adapted from the Numicon intervention and maths activities from the Cbeebies© website.

Week 1: Counting and Number Recognition

Materials Needed: Counters, Number Cards

Small group activity

Find me:

(a) 3 counters [ ]
(b) 5 counters [ ]
(c) 7 counters [ ]
(d) 8 counters [ ]
(e) 10 counters [ ]
(f) 11 counters [ ]
(g) 13 counters [ ]
(h) 14 counters [ ]
(i) 16 counters [ ]
(j) 17 counters [ ]
(k) 19 counters [ ]
(l) 20 counters [ ]
(m) 23 counters [ ]
(n) 24 counters [ ]
(o) 25 counters [ ]

Carpet time activities

Counting: Group counting from 1 (as far as they can go, with a max of 50)

Number recognition: Show the number cards and ask children to say what number is being shown.

Week 2: Colours and Shapes

Materials Needed: Coloured shape cards

Small group activity

Find me:

(a) A yellow square [ ]

(b) A red triangle	[ ]
(c) A blue circle	[ ]
(d) A green rectangle	[ ]
(e) A yellow star	[ ]
(f) A red diamond	[ ]
(g) 2 blue shapes	[ ]
(h) 2 triangles	[ ]
(i) 2 green shapes	[ ]
(j) 2 stars	[ ]
(k) 2 red shapes	[ ]
(l) 2 diamonds	[ ]
(m) 2 yellow shapes	[ ]
(n) 2 circles	[ ]
(o) 2 squares	[ ]

Carpet time activity

Colour and Shape recognition: Show the shape and colour cards and ask children to say what is being shown.

Week 3: Spinners (Addition)

Materials Needed: 2 Spinners

Small group activity

Children spin both spinners and add together the numbers they fall on, e.g. if one spinner lands on a 1 and the second spinner lands on a 4, the sum is 1+4=5.

Carpet time activity

Use the number cards to make a simple addition sum. Ask some children to come up to hold each of the cards, and the other children to work out the answer.

Week 4: Domino Maths

Materials Needed: Numicon dominoes

Small group activity

Children use the dominoes to add together two numbers.

Carpet time activity

Dominoes game from the Cbeebies website.

Week 5: Number Lines

Materials Needed: Number cards

<u>Small group activity</u>

Which number is missing?

(a) 1, 2, 3, 5,
(b) 2, 3, 4, 5
(c) 3, 4, 5, 7
(d) 2, 3, 4, 6,
(e) 1, 2, 4, 5

(f) 2, 4, 5, 8
(g) 2, 5, 6
(h) 1, 3, 4, 5, 7
(i) 1, 2, 3, 6
(j) 3, 4, 5, 7

Put these numbers in order:

(k) 1, 2, 3, 4
(l) 2, 3, 4, 5
(m) 2, 4, 6, 8
(n) 2, 3, 7, 10
(o) 1, 3, 4, 7

<u>Carpet time activity</u>

Give out the number cards to the children and ask them to stand in a line in order.

Then make it harder by taking one number away and asking which is missing.

Week 6: Colour and Shape Matching

Materials Needed:

<u>Small group activity</u>

Find me:

(a) All of the yellow shapes [ ]
(b) All of the circles [ ]
(c) All of the blue shapes [ ]
(d) All of the red shapes [ ]
(e) All of the rectangles [ ]
(f) Two triangles [ ]
(g) Two green shapes [ ]
(h) Two stars [ ]
(i) Two diamonds [ ]
(j) Two blue shapes [ ]
(l) A triangle and a square [ ]
(m) A red shape and a green shape [ ]
(n) A yellow shape and a blue shape [ ]
(o) A red star and a blue rectangle [ ]

<u>Carpet time activity</u>

Shape dominoes activity from the Cbeebies website.

Week 7: Frogs and Lily pads

Materials Needed: Frogs and Lily pads

<u>Small group activity</u>

Only one frog can fit on each lilt pad. Give the child the following and ask if all the frogs have somewhere to sit.

(a) 3 frogs, 4 lily pads
(b) 2 frogs, 6 lily pads
(c) 6 frogs, 5 lily pads
(d) 7 frogs, 8 lily pads
(e) 9 frogs, 7 lily pads
(f) 6 frogs, 7 lily pads
(g) 4 frogs, 3 lily pads
(h) 4 frogs, 5 lily pads
(i) 5 frogs, 4 lily pads
(j) 7 frogs, 6 lily pads
(k) 3 frogs, 3 lily pads
(l) 3 frogs, 4 lily pads
(m) 5 frogs, 6 lily pads
(n) 6 frogs, 6 lily pads
(o) 4 frogs, 8 lily pads

Carpet time activity

Shape game from the Cbeebies website.

Week 8: More or Less? (Counters and Dominos)

Materials Needed: Counters and Dominoes

Small group activity

Children receive a domino and a number of counters. Ask the children to place one counter over each dot on the dominoes to see if there are more or less counters than the number of dots on the dominoes.

	Domino	Counters
(a)	3	4
(b)	5	6
(c)	1	2
(d)	2	5
(e)	4	5
(f)	5	2
(g)	6	8
(h)	9	5
(i)	7	6
(j)	6	4
(k)	8	3
(l)	4	2
(m)	2	3
(n)	8	7
(o)	9	6

Carpet time activity

More or less activity from the Cbeebies website.

Week 9: Spinners (Subtraction)

Materials Needed: 2 Spinners

Small group activity

Children spin the spinners and take the smaller number away from the bigger number, e.g. if one spinner lands on 2 and the other spinner lands on 4, the sum is 4-2=2.

Carpet time activity

Use the number cards to make a simple subtraction sum. Ask children to hold the cards up and the other children to work out the answer.

Week 10: Number Lines

Materials Needed: Number cards, response sheets

Small group activity

As in Week 5, but children are asked to write the numbers down as well as say the answers.

Carpet time activity

Connect 4 from the Cbeebies website.

Appendix 7: Phonological Awareness Intervention for Study 2

Activities adapted from the 'Jolly Phonics' intervention

Children complete three tasks each week and focus on different letter sounds each week within these activities. Each week, one activity involves pictures and letters, one involves thinking of words that contains each of the letter sounds for that week and writing them down, and one involves reading words which contain the letter sounds for that week. The picture activity differs each week and these are listed below along with the focus letters for each week.

Week 1: s, a, t, i, n
Match the beginning sounds to the pictures.

Week 2: p, ck, e, h, r
The end letters are missing from labels on a picture. Fill them in to finish the words.

Week 3: m, d, g, o, u
Write down the sound that each of the pictures start with.

Week 4: , l , f, b, w, v
Fill in the missing letters from the labels.

Week 5: sh, ch, th, y, x
Join each word to its missing sound.

Week 6: ai, j, oa, ie, ee
Unscramble the letters to find the word for each picture.

Week 7: ou, oi, or, er, ar
Match the pictures to the sounds they contain.

Week 8: ue, qu, igh, ir, ur
Join each word to its missing sound.

Week 9: a, ay, ai, a-e
Match the pictures to the correct 'a' sound.

Week 10: e, ee, ea, y, e-e, ie
Match the pictures to the correct 'e' sound.

Appendix 8: Semantic-based Control Intervention for Study 2

Children complete three activities each week.

Picture and Word matching:

Children are required to match 5 pictures to their corresponding written words. Items differ each week.

Categories:

Children are asked to think of 5 things in a category each week. Categories differ each week and include:
1) School lessons
2) Clothing
3) Fruit
4) Vegetables
5) Drinks
6) Celebrations
7) Plants
8) Animals
9) Colours
10) Transport

Synonyms:

Children are asked to think of 5 words that mean the same as a target word. Target words differ each week and include:
1) Happy
2) Sad
3) Good
4) Bad
5) Hot
6) Cold
7) Fast
8) Slow
9) Big
10) Little

Example of score sheet:

Picture/Word Matching	√ / x	Comments
Categories	**√ / x**	**Answers Given**
This week's category is		
Synonyms	**√ / x**	**Comments**
This week's word is		

Appendix 9: Evidence of Ethical Approval for Study 1

1. Project Information

Project Ref: **P5245**

Full name: Emily Harrison

Faculty: [HLS] Faculty of Health and Life Sciences

Department: [SY] Psychology

Module Code:

EFAAF Number:

Supervisor: Clare Wood

Project title: **Evaluating the Potential of a Speech Rhythm-Based Reading Intervention**

Project dates: 10/06/2012 - 28/02/2013

Created: 17/05/2012 13:43

Project summary: This project aims to develop a set of training materials based on developing the speech rhythm sensitivity of children aged 4-5 years as a possible way of enhancing reading performance. The pilot study will enable us to determine the responsiveness of children aged 4-5 years to the training materials and to establish the most effective way of administering these measures. Study 1 will then commence in September and will test the effectiveness of the speech rhythm based intervention compared to other educational interventions for children of this age group.

Names of Co-investigators (CIs) and their organisational affiliation:

How many additional research staff will be employed on the project? 0

Names and their organisational affiliation (if known):

Who is funding the project? The Leverhulme Trust

Has the funding been confirmed? Yes

Code of ethical practice and conduct most relevant to your project: British Psychological Society

2. Does this project need ethical approval?

1	Does the project involve collecting primary data from, or about, living human beings?	Yes
2	Does the project involve analysing primary or unpublished data from, or about, living human beings?	Yes
3	Does the project involve collecting or analysing primary or unpublished data about people who have recently died, other than data that are already in the public domain?	No
4	Does the project involve collecting or analysing primary or unpublished data about or from organisations or agencies of any kind, other than data that are already in the public domain?	No
5	Does the project involve research with non-human vertebrates in their natural settings or behavioural work involving invertebrate species not covered by the Animals Scientific Procedures Act (1986)?	No
6	Does the project place the participants or the researchers in a dangerous environment, risk of physical harm, psychological or emotional distress?	No
7	Does the nature of the project place the participant or researchers in a situation where they are at risk of investigation by the police or security services?	No
8	Does the project involve the researcher travelling outside the UK?	No

If you have answered **Yes** to **any** of these questions, please proceed to **section 3**.

If you answered **No** to **all** of these questions:

- You **do not** need to submit your project for peer review and ethical approval.
- You should sign the Declaration in **Section 17**, and keep a copy for your own records.
- Students must ask their Director of Studies to countersign the declaration, and they should send a copy for you file to the Registry Research Unit.

3. Does the project require Criminal Records Bureau checks?		
1	Does the project involve direct contact by any member of the research team with children or young people under 18 years of age?	Yes
2	Does the project involve direct contact by any member of the research team with adults who have learning difficulties?	No
3	Does the project involve direct contact by any member of the research team with adults who are infirm or physically disabled?	No
4	Does the project involve direct contact by any member of the research team with adults who are resident in social care or medical establishments?	No
5	Does the project involve direct contact by any member of the research team with adults in the custody of the criminal justice system?	No
6	Has a Criminal Records Bureau (CRB) check been stipulated as a condition of access to any source of data required for the project?	Yes

Further information: Data will be collected from children at a primary school(s) in the UK. It is possible that participants will include children with a learning difficulty (e.g., dyslexia) or a physical disability (e.g., be in a wheelchair). So long as they are deemed able to take part, it is possible that they will be recruited to take part in this study. Data will only be collected once informed consent has been received from the head teacher, the child's parents, and the child themselves. A battery of literacy assessments will be administered on a one-to-one basis at the child's school, but this will not take place in a solitary area. Children will also be exposed to either a literacy or maths-based training programme administered by the data collector over a period of 6 weeks. It will be ensured that the data collector has CRB clearance prior to any data collection or contact with the children.

Supervisor comments: Nothing provided

4. Is this project liable to scrutiny by external ethical review arrangements?		
1	Has a favourable ethical opinion been given for this project by a social care research ethics committee, or by any other external research ethics committee?	No
2	Will this project be submitted for ethical approval to a social care committee or any other external research ethics committee?	No

If you have answered **No** to **both** of these questions, please proceed to **section 5**.

If you answered **Yes** to **either** of these questions:

- Sign the Declaration in **section 17** and send a copy to the Registry Research Unit.
- Students must get their Director of Studies to countersign the checklist before submitting.

5. More detail about the project

1. What are the aims and objectives of the project?To develop a speech prosody-based set of training materials and activities suitable for use with pre-school children. To formally evaluate the effectiveness of the speech

prosody-based training materials for improving the early reading skills and phonological skills of pre-school children. 3. To identify whether children whose reading skills improve as a consequence of exposure to the speech prosody intervention are different from children who improve as a result of phonics tuition.

2. Briefly describe the principal methods, the sources of data or evidence to be used and the number and type of research participants who will be recruited to the projectThis project will use an experimental method. Literacy skills such as reading ability, vocabulary and phonological awareness will be assessed using well-documented, standardised, published assessments, and the two control training programmes will be based on standardised interventions (The exception to this is the speech rhythm based training programme which is newly developed). These assessments will be administered to 30 children in the pilot, and 90 children for study 1, all aged between 4 and 5-years-ol

3. What research instrument(s), validated scales or methods will be used to collect data?The following measures will be used to assess the skills noted above: phonological awareness, using alliteration and rhyming subtests from the PhAB (Frederickson, Frith & Reason, 1997); word reading, using the British Ability Scales II (Elliot, Smith & McUlloch, 1996) and a pre-school literacy measure, and vocabulary, using the British Picture Vocabulary Scales III (Dunn et al. 2011). Speech rhythm sensitivity will also be assessed using the Mispronunciations task (Wood, 2006).

4. If you are using an externally research instrument, validated scale or research method, please specify.As above.

5. If you are not using an externally validated scale or research method, please attach a copy of the research instrument you will use to collect data. For example, a measurement scale, questionnaire, interview schedule, observation protocol for ethnographic work or in the case of unstructured data collection a topic list.A new speech rhythm-based training programme will be used to train one group of the children on their speech rhythm sensitivity. The other two groups will receive either a traditional phonics based intervention or a control (maths based) intervention. All children will be trained in small groups once weekly over a six week period. During the training period, those in the speech rhythm group will receive targeted tuition on three crucial aspects of speech rhythm: stress, intonation and timing. Please see exa

6. Confidentiality, security and retention of research data		
1	Are there any reasons why you cannot guarantee the full security and confidentiality of any personal or confidential data collected for the project?	No
2	Is there a significant possibility that any of your participants, or people associated with them, could be directly or indirectly identified in the outputs from this project?	No
3	Is there a significant possibility that confidential information could be traced back to a specific organisation or agency as a result of the way you write up the results of the project?	No
4	Will any members of the project team retain any personal or confidential data at the end of the project, other than in fully anonymised form?	No
5	Will you or any member of the team intend to make use of any confidential information, knowledge, trade secrets obtained for any other purpose than this research project?	No

Further information: Children's names will be required for identification purposes at the recruitment stage of the project, and so that children can be identified as participants to teachers between stages of training. However, consent forms will be sent out via the schools, so no personal addresses will be required. After participation, all children will be referred to as a participant number. If a parent or child chooses to withdraw their data from the study following participation, they will do so by contacting the researcher and quoting their participation number which will be noted on a debrief form. This will enable the researcher to trace that participation number to a set of data and delete it. All original test scores will be kept securely in a locked filing cabinet at Coventry University and will only be available to the principal investigator. Descriptions of the school will be included in the write up (e.g., name of local area, number of students, number of children with SEN, etc), but these will not be explicitly identified.

Supervisor comments: Nothing provided

7. Informed consent		
1	Will all participants be fully informed why the project is being conducted and what their participation will involve, and will this information be given before the project begins?	Yes
2	Will every participant be asked to give written consent to participating in the project, before it begins?	No
3	Will all participants be fully informed about what data will be collected, and what will be done with these data during and after the project?	No
4	Will explicit consent be sought for audio, video or photographic recording of participants?	No
5	Will every participant understand what rights they have not to take part, and/or to withdraw themselves and their data from the project if they do take part?	Yes
6	Will every participant understand that they do not need to give you reasons for deciding not to take part or to withdraw themselves and their data from the project and that there will be no repercussions as a result?	Yes
7	If the project involves deceiving, or covert observation of, participants, will you debrief them at the earliest possible opportunity?	No
8	Participant Information Leaflet attached.	-
9	Informed Consent Form attached.	-

Further information: Informed consent will be established from the child's school and their parents. Consent will also be established from the child prior to any data collection, so that all parties know about the research and can opt not to take part if they wish to do so. However, even if consent has been established, children will still have the opportunity to withdraw at any time during data collection by simply saying that they want to stop, and this will be made clear to them when they provide their own verbal consent prior to the onset of any assessment or intervention period. Parents will also be made aware that they have the right to discuss any feelings or personal matters that may have arisen during the data collection process and that they have the right to withdraw their child from the research at any time. The school is also able to withdraw from the study at any time. However, it is anticipated that schools and parents will be supportive of this project. Other potential risks have also been addressed; for instance, with children coming out of class for the additional literacy or maths training, they will of course be missing some tuition. However, we will try to make sure that testing is done at a convenient time for all parties involved, and it is expected that all children will benefit from training. We will be sensitive to individual child preferences when we select children. We will also be sensitive to the length of testing period and we will strive to include a manageable amount of training or assessments in one session such that the child will not tire or become uncomfortable as a result of too many assessments. Initial contact will be established with the target schools through letter correspondence (see Appendix 2) for the purpose of the pilot study. This will provide a brief outline of the research and contain contact details so that the head teacher has the opportunity to discuss any issues they may have. A similar letter will later be sent out regarding study 1 (see Appendix 3). Schools will also be provi

Supervisor comments: Nothing provided

8. Risk of harm		
1	Is there any significant risk that your project may lead to physical harm to participants or researchers?	No
2	Is there any significant risk that your project may lead to psychological or emotional distress to participants?	No
3	Is there any significant risk that your project may lead harm to the reputation of participants, or their employers, or of any other persons or organisations?	No
4	Is there any significant risk that your project may result in harm to the reputation or participants, researchers, their employers, or other persons or organisations?	No

Further information: There are no ‘significant’ risks, but as this involves some form of cognitive assessment and training, there is always the chance that children will find it difficult and may be uncomfortable as a result of this. However, we must reiterate that tests will be administered at an age-appropriate level and children have the right to withdraw at any time. The test administrator will be sensitive to children’s behaviour during the training process and terminate the session if deemed necessary. Reward stickers will also be given to children at the end of the training period in order to give them a sense of achievement and help them enjoy the whole experience.

Supervisor comments: Nothing provided

9. Risk of disclosure of harm or potential harm		
1	Is there a significant risk that the project will lead participants to disclose evidence of previous criminal offences, or their intention to commit criminal offences?	No
2	Is there a significant risk that the project will lead participants to disclose evidence that children or vulnerable adults are being harmed, or are at risk of harm?	No
3	Is there a significant risk that the project will lead participants to disclose evidence of serious risk of other types of harm?	No

10. Payment of participants		
1	Do you intend to offer participants cash payments or any other kind of inducements or compensation for taking part in your project?	No
2	Is there any significant possibility that such inducements will cause participants to consent to risks that they might not otherwise find acceptable?	No
3	Is there any significant possibility that the prospect of payment or other rewards will systematically skew the data provided by participants in any way?	No
4	Will you inform participants that accepting compensation or inducements does not negate their right to withdraw from the project?	No

Further information: No payment or formal reward will be given to participants although children will be offered stickers as a “well done” for taking part in each training session.

Supervisor comments: Nothing provided

11. Capacity to give valid consent		
1	Do you propose to recruit any participants who are under 18 years of age?	Yes
2	Do you propose to recruit any participants who have learning difficulties?	Yes

11. Capacity to give valid consent		
3	Do you propose to recruit any participants with communication difficulties, including difficulties arising from limited facility with the English language?	No
4	Do you propose to recruit any participants who are very elderly or infirm?	No
5	Do you propose to recruit any participants with mental health problems or other medical problems that may impair their cognitive abilities?	No
6	Do you propose to recruit any participants who may not be able to understand fully the nature of the research and the implications for them of participating in it?	No

Further information: This has all already been noted. An outline of the research will be given in basic terms to children (Appendix 14) and they will have to provide verbal consent to take part. Parental consent will also be established (Appendix 12 and 13 for pilot and study 1 respectively) and has been considered already in an earlier section of this application.

Supervisor comments: Nothing provided

12. Is participation genuinely voluntary?		
1	Are you proposing to recruit participants who are employees or students of Coventry University or of organisation(s) that are formal collaborators in the project?	No
2	Are you proposing to recruit participants who are employees recruited through other business, voluntary or public sector organisations?	No
3	Are you proposing to recruit participants who are pupils or students recruited through educational institutions?	Yes
4	Are you proposing to recruit participants who are clients recruited through voluntary or public services?	No
5	Are you proposing to recruit participants who are living in residential communities or institutions?	No
6	Are you proposing to recruit participants who are in-patients in a hospital or other medical establishment?	No
7	Are you proposing to recruit participants who are recruited by virtue of their employment in the police or armed services?	No
8	Are you proposing to recruit participants who are being detained or sanctioned in the criminal justice system?	No
9	Are you proposing to recruit participants who may not feel empowered to refuse to participate in the research?	No

Further information: We will be recruiting children from primary schools in the UK. The details of the recruitment method have already been considered in an earlier section of this application.

Supervisor comments: Nothing provided

13. Online and Internet Research		
1	Will any part of your project involve collecting data by means of electronic media, such as the Internet or e-mail?	No
2	Is there a significant possibility that the project will encourage children under 18 to access inappropriate websites, or correspond with people who pose risk of harm?	No
3	Is there a significant possibility that the project will cause participants to become distressed or	No

13. Online and Internet Research		
	harmed, in ways that may not be apparent to the researcher(s)	
4	Will the project incur any other risks that arise specifically from the use of electronic media?	No

14. Other ethical risks		
1	Are there any other ethical issues or risks of harm raised by your project that have not been covered by previous questions?	No

15. Research with non-human vertebrates		
1	Will any part of your project involve the study of animals in their natural habitat?	No
2	Will your project involve the recording of behaviour of animals in a non-natural setting that is outside of the control of the researcher?	No
3	Will your field work involve any direct intervention other than recording the behaviour of the animals available for observation?	No
4	Is the species you plan to research endangered, locally rare or part of sensitive ecosystem protected by legislation?	No
5	Is there any significant possibility that the welfare of the target species or those sharing the local environment/habitat will be detrimentally affected?	No
6	Is there any significant possibility that the habitat of the animals will be damaged by the project, such that their health and survival will be endangered?	No
7	Will project work involve intervention work in a non-natural setting in relation to invertebrate species other than Octopus vulgaris?	No

16. Blood Sampling / Human Tissue Analysis	
Does your project involve blood sampling or human tissue analysis?	No

17. Principal Investigator's Declaration	
Most appropriate course of action: I **request an ethics review** and confirm that I have answered all relevant questions in this form honestly.	
I confirm that I will carry out the project in the ways described in this form. I will immediately suspend research and request a new ethical approval if the project subsequently changes the information I have given in this form.	Yes
I confirm that I, and all members of my research team (if any), have read and agree to abide by the code of research ethics issued by the relevant national learned society.	Yes
I confirm that I, and all members of my research team (if any), have read and agree to abide by the University's Research Ethics, Governance and Integrity Framework.	Yes
Attachments	
Participant Information Leaflet attached.	-
Informed Consent Form attached.	-
Health & Safety Assessment attached.	-

17. Principal Investigator's Declaration	
App1 Intervention Outline	
App2 Pilot School Letter	
App3 S1 School Letter	
App4 Pilot Pis Headteacher	
App5 S1 Pis Headteacher	
App6 Pilot Consent Headteacher	
App7 S1 Consent Headteacher	
App8 Pilot Letter To Parents	
App9 S1 Letter To Parents	
App10 Pilot Pis Parents	
App11 S1 Pis Parents	
App12 Pilot Consent Parents	
App13 S1 Consent Parents	
App14 Consent Children	
App15 Debrief School	
App16 Debrief Parents	
Ethicsapp Pilot&study1	

Step	Status	Authoriser	Authorised on
Supervisor	Approved	Clare Wood	Mon, 21 May 2012 11:10 AM
Referrer	Referred to Reviewer	Elaine Cartmill	Mon, 21 May 2012 11:17 AM
Reviewer	Approved	Reviewer	Thu, 24 May 2012 11:19 AM
Finalizer	Approved	Elaine Cartmill	Thu, 24 May 2012 12:52 PM

Appendix 10: Letter to Head Teacher – Study 1

Emily Harrison
PhD Research Student
Department of Psychology and Behavioural Sciences
Coventry University
Priory Street
Coventry
CV1 5FB
Tel: 02476 88 8759
Mob: 07854209075
e-mail: harris86@uni.coventry.ac.uk
[Date]

RE: PhD Research Project

Dear Head Teacher,

My name is Emily Harrison and I am currently enrolled onto a PhD research programme at Coventry University where I am conducting research into children's reading development. Through my research I will be investigating whether a speech rhythm-based reading intervention can help to develop literacy skills in both a group of beginning readers (4-5 year olds). I would like to administer 3 different training programmes to reception children at your school, together with assessments of various literacy skills, namely phonological awareness (an awareness of speech sounds), single word reading, reading comprehension (how well they understand what they read), vocabulary knowledge (how many words they know) and IQ (measured verbally using a special IQ scale developed specifically for children). Children will be randomly allocated to one of three groups, and will receive either the speech rhythm-based training programme, a traditional phonological awareness-based training programme, or a control (maths-based) training programme. It is expected that all children will benefit in some way from the training regardless of which group they are allocated to.

Please note that your school has been selected purely because it is in the Derby area close to where I live.

If you would like to take part
It would be greatly appreciated if you could give permission for me to carry out this study with children at your school. You do not have to participate in this research; however, if you would like to participate, please fill in the consent form (overleaf) and return it to me at your earliest convenience. I will then arrange to provide you with a batch of participant information sheets and parental consent letters that should be sent out via the school to parents/guardians of children in reception classes. (Note: A copy of this consent letter and the participant information sheet are also appended overleaf). Once informed consent is received from parents, I will then arrange a convenient time to begin administering the training programmes to participating children. Data gathered on children and the school will remain confidential and untraceable. All participating children's parents will be debriefed in the form of a letter that will also be sent out via the school after the study has been carried out. I intend to commence Study 1 in September 2012 as soon as the pupils return from the summer break. This is an extensive project, and will require me to be on school premises on a regular basis for the remainder of the current academic year and the duration of the academic year 2012-2013.

If you have any further questions please don't hesitate to contact me on the details above. You may also contact my Director of Studies (Professor Clare Wood) on 02476 88 8226, or via email at c.wood@coventry.ac.uk

I look forward to your reply.
Yours sincerely, *Emily Harrison*

Appendix 11: Head Teacher Participant Information Sheet – Study 1

Participant Information Sheet

Study Title:
Evaluating the Potential of a Speech Rhythm Based Reading Intervention

What is the purpose of the study?
The aim of this study is to investigate whether a set of speech rhythm-based training materials can enhance children's literacy performance.

Why have I been approached?
Your school has been selected for participation on a convenience basis only, for no reason other than that your school is in the Derby area close to where I live.

Do I have to take part?
No. Participation is entirely voluntary. If you change your mind about taking part in the study you can withdraw at any point during the sessions and at any point up until April 2013 by contacting me using the contact details provided at the foot of this letter and quoting the name of your school. If you decide to withdraw, all your schools data will be destroyed and will not be used in the study. There are no consequences to deciding that you no longer wish to participate in the study.

What will happen to me if I take part?
If you agree for children at your school to take part, children will be assessed for their phonological awareness and reading ability on school premises and will then receive one of three training programmes outlined in the appending letter. This will take part in September-December 2012, and children will be then re-assessed for long term effects of the intervention three months following their initial participation.

What are the possible disadvantages and risks of taking part?
There are no obvious risks associated with this study. I have Criminal Records Bureau clearance and the study has been approved by the Coventry University Ethics Committee. However, you are free to withdraw from the study at any point during the sessions and at any point up until April 2013 by contacting me using the contact details provided at the foot of this letter and quoting the name of your school.

What are the possible benefits of taking part?
This research may help to determine whether training on speech rhythm measures can enhance literacy performance. It may provide valuable insights into the ways in which reading skills are taught in schools, and may provide alternative methods for those who do not respond to traditional methods.

What if something goes wrong?
This project has been carefully designed and we do not anticipate any mishaps. However, you are free to withdraw from the study at any point during the sessions and at any point up until April 2013 by contacting me using the contact details provided and quoting the name of your school.

Will my taking part in this study be kept confidential?

Yes. Only I will have access to the raw data. All data gathered from this research will remain confidential and untraceable to your school or any individual child. It will also be kept in a secure filing cabinet at Coventry University. I will only retain the raw data from the project until my final mark for my research has been given. They will then be destroyed. When the data has been entered into a computer file, your scores will only be associated with a code number and I will be the only one who has access to this file.

What will happen to the results of the research study?
The results will be written up and presented as part of my PhD research project. Results may also be presented at academic conferences and/or written up for publication in academic journals.

Who is organising and funding the research?
The research is organised by myself, Emily Harrison, a PhD research student at the Coventry University, in relation to the Psychology and Behavioural Sciences Department. This project is externally funded by the Leverhulme Trust.

Who has reviewed the study?
The Coventry University Ethics Committee has reviewed and approved this study.

Contact for Further Information
If you would like to find out more about this study, please contact me via e-mail at harris86@uni.coventry.ac.uk. You may also contact my Director of Studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk.

Appendix 12: Head Teacher Consent Form – Study 1

Consent form: Approval of your school's participation

Please read Part A then fill in Part B and return this section (A and B) to me at your earliest convenience
You may tear off Part C and keep it for your own records.

Part A

As noted, this study involves administering a set of training materials to a group of children in reception classes. Children will be randomly allocated to either receive the speech rhythm based training, traditional phonics based training, or a maths based training programme. You are able to withdraw from this study at any point up until April 2013. If you do decide to withdraw your data, please contact me using the contact details provided in (part C) and quote the name of your school.

This study is conducted in line with the Code of Conduct, Ethical Principles and Guidelines set out by the British Psychological Society and has already received approval from the Coventry University Ethics Committee.

Part B

In signing below, I understand the nature of this study and I am giving consent for my school to participate in this research. Please provide the following details with thanks.

Name of school: ____

School address: ____

Tel. number: ____

Your full name:____ (Head Teacher)

Your signature:_______________________________ Date: _________ (DD/MM/YYYY)

Part C

You may tear off this section (part C) and keep it for your own records.

Thank you for your participation in this study which aims to investigate whether a set of prosody based training materials can eliminate the deficit in prosodic sensitivity and enhance reading performance. If you have any concerns regarding this research or if you wish to withdraw your school, please contact me via e-mail at harris86@uni.coventry.ac.uk You may also contact my director of studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk

Yours Faithfully, Emily Harrison

Appendix 13: Letter to Parents – Study 1

Emily Harrison
PhD Research Student
Department of Psychology and Behavioural Sciences
Coventry University
Priory Street
Coventry
CV1 5FB
Tel: 02476 88 8759
Mob: 07854209075
e-mail: harris86@uni.coventry.ac.uk

[Date]

Dear Parent/Guardian

My name is Emily Harrison and I am a PhD research student at Coventry University. The Head Teacher at your child's school has agreed to take part in a study which aims to investigate whether a speech rhythm-based reading intervention can help to develop children's reading skills. I would like to randomly allocate your child to one of three groups, where they will receive either a speech rhythm-based training programme, a traditional phonics based training programme, or a maths based training programme. All children are expected to benefit from this training in some way. Your child has been selected on a convenience basis only, for no reason other than that your child is based at this school in the reception class.

What is involved if you would like your child to take part

It would be greatly appreciated if you could give permission for your child to take part in this research. You do not have to agree for your child to take part, but you would like them to participate, please fill in the consent form (overleaf) and return it to the school by [date].

If you agree for your child to take part, he/she will be assessed on established measures of early reading skills and their phonological awareness (awareness of speech sounds) before the intervention period. They will then receive one of the three training programmes as mentioned above which will be administered via a 15-minute weekly training session over 6 weeks. Following the intervention period, they will then be re-assessed on their reading performance and phonological awareness. They will also be assessed on their sensitivity to speech rhythm at the start of the study, using previously developed measures. A delayed post-test for all children will take place around three months later to observe whether the effects of the programme are maintained after training is terminated.

Please be assured that the assessments involved in this research are commonly used with children in the school setting. Data gathered from this research will remain confidential and untraceable to yourself and any individual child. It will also be kept in a secure filing cabinet at Coventry University. Please also be assured that this research will be conducted in line with the Code of Conduct, Ethical Principles and Guidelines set out by the British Psychological Society. This project has already received approval from the Coventry University Ethics Committee. I also have Criminal Records Bureau clearance.

Further information is provided on the Participant Information Sheet (also overleaf). However, if you would like to find out more about this study before you commit, please contact me via e-mail at harris86@uni.coventry.ac.uk. You may also contact my Director of Studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk.

I look forward to your reply.

Yours Faithfully, *Emily Harrison*

Appendix 14: Parental Participation Sheet – Study 1

Participant Information Sheet

Study title:
Evaluating the Potential of a Speech Rhythm Based Reading Intervention

What is the purpose of the study? The aim of this study is to investigate whether a set of speech rhythm-based training materials can enhance children's literacy performance.

Why have I been approached?
Your child has been selected for participation on a convenience basis only, for no reason other than that your child is based at this school and is in the reception class.

Do I have to take part?
No. Participation is entirely voluntary. If you change your mind about taking part in the study you can withdraw at any point during the sessions and at any point up until April 2013 by contacting me using the contact details provided at the foot of this letter and quoting the name of your child. If you decide to withdraw, all your child's data will be destroyed and will not be used in the study. There are no consequences to deciding that you no longer wish to participate in the study.

What will happen to me if I take part?
If you agree for your child to take part, your child will be assessed for their phonological awareness and reading ability on school premises and will then receive one of three training programmes outlined in the appending letter. This will take part in September-December 2012, and your child will be re-assessed for long term effects of the intervention three months following their initial participation.

What are the possible disadvantages and risks of taking part?
There are no obvious risks associated with this study. I have Criminal Records Bureau clearance and the Head Teachers is supportive of this study. However, you are free to withdraw from the study at any point during the sessions and at any point up until April 2013 by contacting me using the contact details provided at the foot of this letter and quoting the name of your child.

What are the possible benefits of taking part?
This research may help to determine whether training on speech rhythm measures can enhance literacy performance. It may provide valuable insights into the ways in which reading skills are taught in schools, and may provide alternative methods for those who do not respond to traditional methods.

What if something goes wrong?
This project has been carefully designed and we do not anticipate any mishaps. However, you are free to withdraw from the study at any point during the sessions and at any point up until April 2013 by contacting me using the contact details provided and quoting the name of your child.

Will my taking part in this study be kept confidential?
Yes. Only I will have access to the raw data. All data gathered from this research will remain confidential and untraceable to yourself and any individual child. It will also be kept in a secure filing cabinet at Coventry University. I will only retain the raw data from the project until my final mark for my research has been given. They will then be destroyed. When the

data has been entered into a computer file, your scores will only be associated with a code number and I will be the only one who has access to this file.

What will happen to the results of the research study?
The results will be written up and presented as part of my PhD research project. Results may also be presented at academic conferences and/or written up for publication in academic journals.

Who is organising and funding the research?
The research is organised by myself, Emily Harrison, a PhD research student at the Coventry University, in relation to the Psychology and Behavioural Sciences Department. This project is externally funded by the Leverhulme Trust.

Who has reviewed the study?
The Coventry University Ethics Committee has reviewed and approved this study.

Contact for Further Information
If you would like to find out more about this study, please contact me via e-mail at harris86@uni.coventry.ac.uk. You may also contact my Director of Studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk.

Appendix 15: Parental Consent Form – Study 1

Consent form: Approval of you and your child's participation

Please read Part A then fill in Part B and return this section (A and B) to the secretary at your child's school at your earliest convenience
You may tear off Part C and keep it for your own records.

Part A

As noted, this study involves administering a set of training materials to your child within their school environment. If you agree for your child to take part, they will be randomly allocated to one of three groups and will receive either a speech rhythm-based training programme (teaching them about stress, intonation and timing in language), a traditional phonics based training programme (teaching them about speech sounds), or a maths based training programme (teaching them about numbers). You are able to withdraw from this study at any point up until April 2013. If you do decide to withdraw your data, please contact me using the contact details provided in Part C and quote the name of your child.

This study is conducted in line with the Code of Conduct, Ethical Principles and Guidelines set out by the British Psychological Society and has already received approval from the Coventry University Ethics Committee.

Part B

In signing below, I understand the nature of this study and I am giving consent for my child to participate in this research.

Please provide the following details with thanks.

Child's full name: ________________________________ Child's class: _____________

Your full name: ________________________________ (Parent/Guardian)

Your signature: ______________________________ Date:__________ (DD/MM/YYYY)

Part C

You may tear off this section (part C) and keep it for your own records.

Thank you for your participation in this study which aims to investigate whether a set of speech rhythm-based training materials can eliminate the deficit in prosodic sensitivity and enhance reading performance. If you have any concerns regarding this research or if you wish to withdraw your child, please contact me via e-mail at harris86@uni.coventry.ac.uk You may also contact my director of studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk

Yours Faithfully,

Emily Harrison

Appendix 16: Participant Briefing Form – Study 1

To be read to reception children

Hello (Name)

My name is Emily and today I would like to play some learning games with you. There are 3 different activities in total and this should last about 15 minutes. Then I will come back another day and if you still want to then we can play the games again. After we have played the games today you can return to class. The Head Teacher of your school and your parents/guardians are happy for me to work on these activities with you.

Would you like to work on these activities with me? YES/NO

Soon we will start the games. If at any point during the activities you feel that you no longer want to do them and that you would prefer to return to class simply say STOP and we will stop. I will then return you to class.

Do you have any questions before we start?

Appendix 17: Debriefing Letter to Head Teacher – Study 1

Emily Harrison
PhD Research Student
Department of Psychology and Behavioural Sciences
Coventry University
Priory Street
Coventry
CV1 5FB
Tel: 02476 88 8759
Mob: 07854209075
e-mail: harris86@uni.coventry.ac.uk

[Date]

Dear Head Teacher

In September 2012 - March 2013, your school participated in a research project which investigated whether a set of speech rhythm-based training materials could eliminate the deficit in speech rhythm sensitivity (knowledge and awareness of elements of speech such as stress, intonation and timing) and enhance reading performance. We would like to thank you for your kind participation.

Reminder of the purpose of this project

This project aimed to discover whether a set of speech rhythm-based reading intervention could eliminate the deficit in speech-rhythm sensitivity as a possible way of enhancing reading performance.

What we found

Add.

If you would like to discuss the findings of this study in more detail, please contact me via telephone on 07854209075, or via e-mail at harris86@uni.coventry.ac.uk. You may also contact my Director of Studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk.

Yours Faithfully,

Emily Harrison

Appendix 18: Debriefing Letter to Parents – Study 1

Emily Harrison
PhD Research Student
Department of Psychology and Behavioural Sciences
Coventry University
Priory Street
Coventry
CV1 5FB
Tel: 02476 88 8759
Mob: 07854209075
e-mail: harris86@uni.coventry.ac.uk

[Date]

Dear Parents/ Guardians

In September 2012 - March 2013, your child participated in a research project which investigated whether a set of prosody based training materials could eliminate the deficit in speech rhythm sensitivity (knowledge and sensitivity to elements of language such as stress, intonation and timing in speech) and enhance reading performance. We would like to thank you for your child’s participation.

Reminder of the purpose of this project

This project aimed to discover whether a set of speech rhythm-based reading intervention could eliminate the deficit in speech-rhythm sensitivity as a possible way of enhancing reading performance.

What we found

Add.

If you would like to discuss the findings of this study in more detail, please contact me via telephone on 07854209075, or via e-mail at harris86@coventry.ac.uk. You may also contact my Director of Studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk.

Yours Faithfully,

Emily Harrison

Appendix 19: Evidence of Ethical Approval for Study 2

1. Project Information

Project Ref: **P11683**

Full name: Emily Harrison

Faculty: [HLS] Faculty of Health and Life Sciences

Department: [SY] Psychology

Module Code:

EFAAF Number:

Supervisor: Clare Wood

Project title: **Evaluating the Potential of a Speech Rhythm Based Reading Intervention**

Project dates: 15/04/2013 - 31/03/2014

Created: 21/02/2013 17:30

Project summary:A well established literature has demonstrated the contribution of segmental phonological awareness to reading, leading to the development of many successful phonic interventions. However, despite good general evidence of effectiveness, not all children with reading difficulties respond to this approach to reading tuition. In addition, literature has largely ignored the potential contribution of suprasegmental phonology, which comprises the components of language which accompany phonological awareness, such as stress, intonation and timing. Despite an ongoing literature demonstrating a robust relationship between sensitivity to these prosodic elements and reading, there has, to date, been no intervention which has aimed to remediate the deficit in prosodic sensitivity as a possible way of enhancing reading performance. In this study, Year 3 children will be randomly allocated to one of three treatment groups, receiving either a speech rhythm-based intervention, a traditional phonics based intervention, or a control (semantic-based) intervention over a 10 week period. Participating children will also be assessed on pre- and post-test measures of various literacy skills.

Names of Co-investigators (CIs) and their organisational affiliation:n/a

How many additional research staff will be employed on the project? 0

Names and their organisational affiliation (if known):n/a

Who is funding the project? The Leverhulme Trust

Has the funding been confirmed? Yes

Code of ethical practice and conduct most relevant to your project:British Psychological Society

2. Does this project need ethical approval?

1	Does the project involve collecting primary data from, or about, living human beings?	Yes
2	Does the project involve analysing primary or unpublished data from, or about, living human beings?	Yes
3	Does the project involve collecting or analysing primary or unpublished data about people who have recently died, other than data that are already in the public domain?	No
4	Does the project involve collecting or analysing primary or unpublished data about or from organisations or agencies of any kind, other than data that are already in the public domain?	No

2. Does this project need ethical approval?		
5	Does the project involve research with non-human vertebrates in their natural settings or behavioural work involving invertebrate species not covered by the Animals Scientific Procedures Act (1986)?	No
6	Does the project place the participants or the researchers in a dangerous environment, risk of physical harm, psychological or emotional distress?	No
7	Does the nature of the project place the participant or researchers in a situation where they are at risk of investigation by the police or security services?	No
8	Does the project involve the researcher travelling outside the UK?	No

If you have answered **Yes** to **any** of these questions, please proceed to **section 3**.

If you answered **No** to **all** of these questions:

- You **do not** need to submit your project for peer review and ethical approval.
- You should sign the Declaration in **Section 17**, and keep a copy for your own records.
- Students must ask their Director of Studies to countersign the declaration, and they should send a copy for you file to the Registry Research Unit.

3. Does the project require Criminal Records Bureau checks?		
1	Does the project involve direct contact by any member of the research team with children or young people under 18 years of age?	Yes
2	Does the project involve direct contact by any member of the research team with adults who have learning difficulties?	No
3	Does the project involve direct contact by any member of the research team with adults who are infirm or physically disabled?	No
4	Does the project involve direct contact by any member of the research team with adults who are resident in social care or medical establishments?	No
5	Does the project involve direct contact by any member of the research team with adults in the custody of the criminal justice system?	No
6	Has a Criminal Records Bureau (CRB) check been stipulated as a condition of access to any source of data required for the project?	Yes

Further information: Data will be collected from children at primary schools in the UK. It is possible that participants will include children with a learning difficulty (e.g., dyslexia) or a physical disability (e.g., be in a wheelchair). So long as they are deemed able to take part, it is possible that they will be recruited to take part in this study. Data will only be collected once informed consent has been received from the head teacher, the child's parents, and the child themselves. A battery of literacy assessments will be administered on a one-to-one basis at the child's school, but this will not take place in a solitary area. Children will also be exposed to a literacy-based training programme administered by the data collector over a period of 10 weeks. It will be ensured that the data collector has CRB clearance prior to any data collection or contact with the children.

Supervisor comments: Nothing provided

4. Is this project liable to scrutiny by external ethical review arrangements?		
1	Has a favourable ethical opinion been given for this project by a social care research ethics committee, or by any other external research ethics committee?	No
2	Will this project be submitted for ethical approval to a social care committee or any other external research ethics committee?	No

If you have answered **No** to **both** of these questions, please proceed to **section 5**.

If you answered **Yes** to **either** of these questions:

- Sign the Declaration in **section 17** and send a copy to the Registry Research Unit.
- Students must get their Director of Studies to countersign the checklist before submitting.

5. More detail about the project

1. What are the aims and objectives of the project?1.To develop a speech prosody-based set of training materials suitable for use with children aged 7-8 years who may be struggling with reading. 2. To formally evaluate the effectiveness of the speech prosody-based training materials for improving the word reading and reading comprehension skills in 7-8 year old struggling readers. 3. To identify whether children whose reading skills improve as a consequence of exposure to the speech prosody intervention are different from children who improve as a result of phonics tuition.

2. Briefly describe the principal methods, the sources of data or evidence to be used and the number and type of research participants who will be recruited to the projectThis project will use an experimental method. Literacy skills such as reading ability, phonological awareness and IQ will be assessed using well-documented, standardised, published assessments, and the two control training programmes will be based on standardised interventions (The exception to this is the speech rhythm based training programme which is newly developed). These assessments will be administered to a maximum of 90 children, all aged between 7 and 8-years-old from primary schools in the UK. This sample size is deemed adequate for the anticipated analyses.

3. What research instrument(s), validated scales or methods will be used to collect data?The following measures will be used to assess the skills noted above: phonological awareness, using the Phonological Assessment Battery (Frederickson, Frith & Reason, 1997); word reading, using the Diagnostic Test of Word Reading Processes (Forum for Research in Language and Literacy, 2011); reading comprehension, using the York Assessment of Reading for Comprehension (Hulme, Stothard, Clarke, Bowyer-Crane, Harrington, Truelove & Snowling, 2009); and IQ, using the Wechsler Abbreviated Scale of Intelligence (Wechsler, 2011).

4. If you are using an externally research instrument, validated scale or research method, please specify.As above.

5. If you are not using an externally validated scale or research method, please attach a copy of the research instrument you will use to collect data. For example, a measurement scale, questionnaire, interview schedule, observation protocol for ethnographic work or in the case of unstructured data collection a topic list.If you are not using an externally validated scale or research method, please attach a copy of the research instrument you will use to collect data. For example, a measurement scale, questionnaire, interview schedule, observation protocol for ethnographic work or, in the case of unstructured data collection, a topic list. A new speech rhythm-based training programme will be used to train one group of the children on their speech rhythm sensitivity. The other two groups will receive either a traditional phonics based intervention or a control (semantic based) intervention. All children will be trained in small groups once weekly over a ten week period. During the training period, those

in the speech rhythm group will receive targeted tuition on three crucial aspects of speech rhythm: stress, intonation and timing. Please see examples of the items for the speech rhythm-based training programme as attached in Appendix 1.

6. Confidentiality, security and retention of research data		
1	Are there any reasons why you cannot guarantee the full security and confidentiality of any personal or confidential data collected for the project?	No
2	Is there a significant possibility that any of your participants, or people associated with them, could be directly or indirectly identified in the outputs from this project?	No
3	Is there a significant possibility that confidential information could be traced back to a specific organisation or agency as a result of the way you write up the results of the project?	No
4	Will any members of the project team retain any personal or confidential data at the end of the project, other than in fully anonymised form?	No
5	Will you or any member of the team intend to make use of any confidential information, knowledge, trade secrets obtained for any other purpose than this research project?	No

Further information: Children's names will be required for identification purposes at the recruitment stage of the project, and so that children can be identified as participants to teachers between stages of training. However, consent forms will be sent out via the schools, so no personal addresses will be required. After participation, all children will be referred to as a participant number. If a parent or child chooses to withdraw their data from the study following participation, they will do so by contacting the researcher and quoting their participation number which will be noted on a debrief form. This will enable the researcher to trace that participation number to a set of data and delete it. All original test scores will be kept securely in a locked filing cabinet at Coventry University and will only be available to the principal investigator. Descriptions of the school will be included in the write up (e.g., name of local area, number of students, number of children with SEN, etc), but these will not be explicitly identified.

Supervisor comments: Nothing provided

7. Informed consent		
1	Will all participants be fully informed why the project is being conducted and what their participation will involve, and will this information be given before the project begins?	Yes
2	Will every participant be asked to give written consent to participating in the project, before it begins?	No
3	Will all participants be fully informed about what data will be collected, and what will be done with these data during and after the project?	No
4	Will explicit consent be sought for audio, video or photographic recording of participants?	No
5	Will every participant understand what rights they have not to take part, and/or to withdraw themselves and their data from the project if they do take part?	Yes

7. Informed consent		
6	Will every participant understand that they do not need to give you reasons for deciding not to take part or to withdraw themselves and their data from the project and that there will be no repercussions as a result?	Yes
7	If the project involves deceiving, or covert observation of, participants, will you debrief them at the earliest possible opportunity?	Yes
8	Participant Information Leaflet attached.	
9	Informed Consent Form attached.	

Further information: Informed consent will be established from the child's school and their parents. Consent will also be established from the child prior to any data collection, so that all parties know about the research and can opt not to take part if they wish to do so. However, even if consent has been established, children will still have the opportunity to withdraw at any time during data collection by simply saying that they want to stop, and this will be made clear to them when they provide their own verbal consent prior to the onset of any assessment or intervention period. Parents will also be made aware that they have the right to discuss any feelings or personal matters that may have arisen during the data collection process and that they have the right to withdraw their child from the research at any time. The school is also able to withdraw from the study at any time. However, it is anticipated that schools and parents will be supportive of this project. Other potential risks have also been addressed; for instance, with children coming out of class for the additional literacy-based training, they will of course be missing some tuition. However, we will try to make sure that testing is done at a convenient time for all parties involved, and it is expected that all children will benefit from training. We will be sensitive to individual child preferences when we select children. We will also be sensitive to the length of testing period and if it is believed that the child is tiring or becoming uncomfortable as a result of too many assessments, they will be returned to class. Initial contact will be established with the target schools through letter correspondence (see Appendix 2). This will provide a brief outline of the research and contain contact details so that the head teacher has the opportunity to discuss any issues they may have. They will also be provided with a participant information sheet (Appendix 3). If they are willing to participate they must then return a consent form (Appendix 4) to the researcher. A c

Supervisor comments: Nothing provided

8. Risk of harm		
1	Is there any significant risk that your project may lead to physical harm to participants or researchers?	No
2	Is there any significant risk that your project may lead to psychological or emotional distress to participants?	No
3	Is there any significant risk that your project may lead harm to the reputation of participants, or their employers, or of any other persons or organisations?	No
4	Is there any significant risk that your project may result in harm to the reputation or participants,	No

8. Risk of harm		
	researchers, their employers, or other persons or organisations?	

Further information: There are no 'significant' risks, but as this involves some form of cognitive assessment and training, there is always the chance that children will find it difficult and may be uncomfortable as a result of this. However, we must reiterate that tests will be administered at an age-appropriate level and children have the right to withdraw at any time. The test administrator will be sensitive to children's behaviour during the training process and terminate the session if deemed necessary. Reward stickers will also be given to children at the end of each training period in order to give them a sense of achievement and help them enjoy the whole experience.

Supervisor comments: Nothing provided

9. Risk of disclosure of harm or potential harm		
1	Is there a significant risk that the project will lead participants to disclose evidence of previous criminal offences, or their intention to commit criminal offences?	No
2	Is there a significant risk that the project will lead participants to disclose evidence that children or vulnerable adults are being harmed, or are at risk of harm?	No
3	Is there a significant risk that the project will lead participants to disclose evidence of serious risk of other types of harm?	No

Further information: N/A

Supervisor comments: Nothing provided

10. Payment of participants		
1	Do you intend to offer participants cash payments or any other kind of inducements or compensation for taking part in your project?	No
2	Is there any significant possibility that such inducements will cause participants to consent to risks that they might not otherwise find acceptable?	No
3	Is there any significant possibility that the prospect of payment or other rewards will systematically skew the data provided by participants in any way?	No
4	Will you inform participants that accepting compensation or inducements does not negate their right to withdraw from the project?	No

Further information: No payment or formal reward will be given to participants although children will be offered stickers as a "well done" for taking part in each training session.

Supervisor comments: Nothing provided

11. Capacity to give valid consent		
1	Do you propose to recruit any participants who are under 18 years of age?	Yes

11. Capacity to give valid consent		
2	Do you propose to recruit any participants who have learning difficulties?	Yes
3	Do you propose to recruit any participants with communication difficulties, including difficulties arising from limited facility with the English language?	No
4	Do you propose to recruit any participants who are very elderly or infirm?	No
5	Do you propose to recruit any participants with mental health problems or other medical problems that may impair their cognitive abilities?	No
6	Do you propose to recruit any participants who may not be able to understand fully the nature of the research and the implications for them of participating in it?	No

Further information: This has all already been noted. An outline of the research will be given in basic terms to children (Appendix 8) and they will have to provide verbal consent to take part. Parental consent will also be established (Appendix 7) and has been considered already in an earlier section of this application.

Supervisor comments: Nothing provided

12. Is participation genuinely voluntary?		
1	Are you proposing to recruit participants who are employees or students of Coventry University or of organisation(s) that are formal collaborators in the project?	No
2	Are you proposing to recruit participants who are employees recruited through other business, voluntary or public sector organisations?	No
3	Are you proposing to recruit participants who are pupils or students recruited through educational institutions?	Yes
4	Are you proposing to recruit participants who are clients recruited through voluntary or public services?	No
5	Are you proposing to recruit participants who are living in residential communities or institutions?	No
6	Are you proposing to recruit participants who are in-patients in a hospital or other medical establishment?	No
7	Are you proposing to recruit participants who are recruited by virtue of their employment in the police or armed services?	No
8	Are you proposing to recruit participants who are being detained or sanctioned in the criminal justice system?	No
9	Are you proposing to recruit participants who may not feel empowered to refuse to participate in the research?	No

Further information: We will be recruiting children from primary schools in the UK. The details of the recruitment method have already been considered in an earlier section of this application.

Supervisor comments: Nothing provided

13. Online and Internet Research

1	Will any part of your project involve collecting data by means of electronic media, such as the Internet or e-mail?	No
2	Is there a significant possibility that the project will encourage children under 18 to access inappropriate websites, or correspond with people who pose risk of harm?	No
3	Is there a significant possibility that the project will cause participants to become distressed or harmed, in ways that may not be apparent to the researcher(s)	No
4	Will the project incur any other risks that arise specifically from the use of electronic media?	No

Further information: N/A

Supervisor comments: Nothing provided

14. Other ethical risks

1	Are there any other ethical issues or risks of harm raised by your project that have not been covered by previous questions?	No

Further information: N/A

Supervisor comments: Nothing provided

15. Research with non-human vertebrates

1	Will any part of your project involve the study of animals in their natural habitat?	No
2	Will your project involve the recording of behaviour of animals in a non-natural setting that is outside of the control of the researcher?	No
3	Will your field work involve any direct intervention other than recording the behaviour of the animals available for observation?	No
4	Is the species you plan to research endangered, locally rare or part of sensitive ecosystem protected by legislation?	No
5	Is there any significant possibility that the welfare of the target species or those sharing the local environment/habitat will be detrimentally affected?	No
6	Is there any significant possibility that the habitat of the animals will be damaged by the project, such that their health and survival will be endangered?	No
7	Will project work involve intervention work in a non-natural setting in relation to invertebrate species other than Octopus vulgaris?	No

16. Blood Sampling / Human Tissue Analysis

Does your project involve blood sampling or human tissue analysis?	No

17. Principal Investigator's Declaration

Most appropriate course of action:
I **request an ethics review** and confirm that I have answered all relevant questions in this form honestly.

15. Research with non-human vertebrates	
I confirm that I will carry out the project in the ways described in this form. I will immediately suspend research and request a new ethical approval if the project subsequently changes the information I have given in this form.	Yes
I confirm that I, and all members of my research team (if any), have read and agree to abide by the code of research ethics issued by the relevant national learned society.	Yes
I confirm that I, and all members of my research team (if any), have read and agree to abide by the University's Research Ethics, Governance and Integrity Framework.	Yes

Attachments	
Participant Information Leaflet attached.	
Informed Consent Form attached.	
Health & Safety Assessment attached.	-
App2 Letter To Schools	
App6 Pis Parents	
App7 Opt Out Consent Parents	
Ethicsapp Study 2	
App9 Debrief School	
App10 Debrief Parents	
App1 Intervention Outlines	
App5 Letter To Parents	
App8 Consent Children	

Supervisor	Approved	Clare Wood	Tue, 26 Feb 2013 02:43 PM
Referrer	Referred to Reviewer	Joanna Hemming	Tue, 12 Mar 2013 10:38 AM
Reviewer	Approved (minor conditions)	Reviewer	Tue, 12 Mar 2013 12:10 PM
Finalizer	Approved	Elaine Cartmill	Wed, 14 Aug 2013 02:34 PM

Appendix 20: Letter to Head Teacher – Study 2

Emily Harrison
PhD Research Student
Department of Psychology and Behavioural Sciences
Coventry University
Priory Street
Coventry
CV1 5FB
Tel: 02476 88 8759
Mob: 07854209075
e-mail: harris86@uni.coventry.ac.uk

[Date]

RE: PhD Research Project

Dear Head Teacher,

My name is Emily Harrison and I am currently enrolled onto a PhD research programme at Coventry University where I am conducting research into children's reading development.

Through my research I am investigating whether training on a speech rhythm-based reading intervention can help to develop literacy skills in a group of children who have already been exposed to 2-3 years of formal reading tuition, but who may be struggling as they begin to tackle multisyllabic word reading. With your consent, I would like to administer a simple word reading assessment to Year 3 children at your school. This will enable me to identify those who are performing below the expected level for their age group. I would then like to administer three different training programmes to these children, together with assessments of various literacy skills. Children will be assessed on their single word reading ability (how many words they can read), reading comprehension (how well they understand what they read), phonological awareness (awareness of speech sounds) and IQ (measured verbally using a special IQ scale developed specifically for children).

Children will be randomly allocated to one of three groups, and will receive either a speech rhythm-based training programme developed by myself, a traditional phonological awareness-based training programme, or a semantic-based training programme. It is expected that all children will benefit in some way from the training regardless of which group they are allocated to.

Please note that your school has been selected purely because it is in the Coventry area.

If you would like to take part
It would be greatly appreciated if you could give permission for me to carry out this study with children at your school. You do not have to participate in this research; however, if you would like to participate, please fill in the consent form (overleaf) and return it to me at your earliest convenience. I will then arrange a convenient time to administer the screening assessment to all Year 3 children. Following this, I will provide you with a batch of participant

information sheets and parental consent letters that should be sent out via the school to parents/guardians of selected children in Year 3. (Note: A copy of this consent letter and the participant information sheet are also appended overleaf). We will be using an 'opt-out' procedure whereby parents only need to send back the form if they **do not** wish their child to take part. I will then arrange a convenient time to begin administering the training materials to participating children. Data gathered on children and the school will remain confidential and untraceable. I intend to commence data collection in April 2013 as soon as children return from their Easter break.

If you have any further questions please don't hesitate to contact me using the details above.

You may also contact my Director of Studies (Professor Clare Wood) on 02476 88 8226, or

via email at c.wood@coventry.ac.uk

I look forward to your reply.

Yours sincerely,
Emily Harrison

Appendix 21: Head Teacher Participant Information Sheet – Study 2

Participant Information Sheet

Study title:
Evaluating the Potential of a Speech Rhythm Based Reading Intervention

What is the purpose of the study?
The aim of this study is to investigate whether a set of speech rhythm-based training materials can enhance children's literacy performance.

Why have I been approached?
Your school has been selected for participation on a convenience basis only, for no reason other than that your school is in the Coventry area.

Do I have to take part?
No. Participation is entirely voluntary. If you change your mind about taking part in the study you can withdraw at any point during the sessions and at any point up until March 2014 by contacting me using the contact details provided at the foot of this letter and quoting the name of your school. If you decide to withdraw, all your schools data will be destroyed and will not be used in the study. There are no consequences to deciding that you no longer wish to participate in the study.

What will happen to me if I take part?
If you agree for children at your school to take part, children will be assessed on their reading performance to identify children who are performing below the expected level for their age group. Selected children will then be assessed on various literacy skills on school premises and will then receive one of three training programmes outlined in the appending letter. This will take part between September-December 2013, and children will be then re-assessed for long term effects of the intervention three months following participation, in March 2014.

What are the possible disadvantages and risks of taking part?
There are no obvious risks associated with this study. I have Criminal Records Bureau clearance and the study has been approved by the Coventry University Ethics Committee. However, you are free to withdraw from the study at any point during the sessions and at any point up until March 2014 by contacting me using the contact details provided at the foot of this letter and quoting the name of your school.

What are the possible benefits of taking part?
This research may help to determine whether training on speech rhythm measures can enhance literacy performance. It may provide valuable insights into the ways in which reading skills are taught in schools, and may provide alternative methods for those who do not respond to traditional methods.

What if something goes wrong?

This project has been carefully designed and we do not anticipate any mishaps. However, you are free to withdraw from the study at any point during the sessions and at any point up until March 2014 by contacting me using the contact details provided and quoting the name of your school.

Will my taking part in this study be kept confidential?
Yes. Only I will have access to the raw data. All data gathered from this research will remain confidential and untraceable to your school or any individual child. It will also be kept in a secure filing cabinet at Coventry University. I will only retain the raw data from the project until my final mark for my research has been given. They will then be destroyed. When the data has been entered into a computer file, your scores will only be associated with a code number and I will be the only one who has access to this file.

What will happen to the results of the research study?
The results will be written up and presented as part of my PhD research project. Results may also be presented at academic conferences and/or written up for publication in academic journals.

Who is organising and funding the research?
The research is organised by myself, Emily Harrison, a PhD research student at the Coventry University, in relation to the Psychology and Behavioural Sciences Department. This project is externally funded by the Leverhulme Trust.

Who has reviewed the study?
The Coventry University Ethics Committee has reviewed and approved this study.

Contact for Further Information
If you would like to find out more about this study, please contact me via e-mail at harris86@uni.coventry.ac.uk. You may also contact my Director of Studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk.

Appendix 22: Head Teacher Consent Form – Study 2

Consent form: Approval of your school's participation

Please read **Part A** then fill in **Part B** and return this section (A and B) to me at your earliest convenience

You may tear off **Part C** and keep it for your own records.

Part A

As noted, this study involves administering a set of training materials to a group of children in Year 3. Children will be randomly allocated to either receive the speech rhythm based training, traditional phonics based training, or a semantic-based training programme. You are able to withdraw from this study at any point up until March 2014. If you do decide to withdraw your data, please contact me using the contact details provided in (part C) and quote the name of your school.

This study is conducted in line with the Code of Conduct, Ethical Principles and Guidelines set out by the British Psychological Society and has already received approval from the Coventry University Ethics Committee.

Part B

In signing below, I understand the nature of this study and I am giving consent for my school to participate in this research. Please provide the following details with thanks.

Name of school: ____

School address: ____

Tel. number: ____

Your full name:____________________________________ (Head Teacher)

Your signature:________________________ Date: _______ (DD/MM/YYYY)

Part C

You may tear off this section (part C) and keep it for your own records.

Thank you for your participation in this study which aims to investigate whether a set of speech rhythm-based training materials can eliminate the deficit in speech rhythm sensitivity and enhance reading performance. If you have any concerns regarding this research or if you wish to withdraw your school, please contact me via e-mail at harris86@uni.coventry.ac.uk You may also contact my director of studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk

Appendix 23: Letter to Parents – Study 2

Emily Harrison
PhD Research Student
Department of Psychology and Behavioural Sciences
Coventry University
Priory Street
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CV1 5FB
Tel: 02476 88 8759
Mob: 07854209075
e-mail: harris86@uni.coventry.ac.uk

[Date]

Dear Parent/Guardian of

My name is Emily Harrison and I am a PhD research student at Coventry University. The Head Teacher at your child's school has agreed to take part in a study which aims to investigate whether a speech rhythm-based reading intervention can help to develop the reading skills of children who have already received some formal reading tuition but who may be struggling to grasp the concepts necessary for multisyllabic word reading.

Your child has already completed a basic reading assessment which has illustrated a level of performance below that which we would expect from a child in their age group. I would like to randomly allocate your child to one of three literacy intervention groups, where they will receive either a speech rhythm-based training programme, a traditional phonics based training programme, or a semantic-based training programme. All children are expected to benefit from this training in some way.

Your child has been selected on the basis that they are a Year 3 pupil at this school, and have performed below average on a standardised reading test. Please note that the reading assessment already completed is commonly used with children within the school setting and is designed to measure single word reading performance only. If you have any concerns regarding your child's progress that are unrelated to this research, please contact the school directly.

What is involved if you would like your child to take part

It would be greatly appreciated if you could give permission for your child to take part in this research. If you would like them to take part, we require no further action. However, if you **do not** wish for them to take part, please fill in the opt-out form (overleaf) and return it to the school by **date**. If you do not return the form by this date, we will assume that you consent to your child's participation.

If you agree for your child to take part, he/she will be assessed on established measures of word reading (how many words they can read), reading comprehension (how well they understand what they read), phonological awareness (awareness of speech sounds), and general intelligence (measured verbally using a special IQ test developed specifically for children), before the intervention period. They will then receive one of the three training programmes as mentioned above which will be administered via a 15 minute weekly training session over 10 weeks. Following the intervention period, they will then be re-assessed on their reading performance and phonological awareness. They will also be assessed on their sensitivity to speech rhythm. A delayed post-test for all children will take place in [month] to observe whether the effects of the programme are maintained after training is terminated. Please be assured that the assessments involved in this research are all commonly used with children in the school setting. Data gathered from this research will remain confidential and untraceable to any individual child. It will also be kept in a secure filing cabinet at Coventry University. Please also be assured that this research will be conducted in line with the Code of Conduct, Ethical Principles and Guidelines set out by the British Psychological Society. This project has already received approval from the Coventry University Ethics Committee. I also have Criminal Records Bureau clearance.

Further information is provided on the Participant Information Sheet (overleaf). However, if you would like to find out more about this study before you commit, please contact me via e-mail at harris86@uni.coventry.ac.uk. You may also contact my Director of Studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk.

Yours Faithfully,

Emily Harrison

Appendix 24: Parental Participant Information Sheet – Study 2

Participant Information Sheet

Study title:
Evaluating the Potential of a Speech Rhythm Based Reading Intervention

What is the purpose of the study?
The aim of this study is to investigate whether a set of speech rhythm-based training materials can enhance the literacy performance of 7-8 year-old struggling readers.

Why have I been approached?
Your child has been selected for participation on the basis that they are in Year 3 at this school, and have shown a level of reading performance below that expected for a child in their age group.

Do I have to take part?
No. Participation is entirely voluntary. If you change your mind about taking part in the study you can withdraw at any point during the sessions and at any point up until March 2014 by contacting me using the contact details provided at the foot of this letter and quoting the name of your child. If you decide to withdraw, all your child's data will be destroyed and will not be used in the study. There are no consequences to deciding that you no longer wish to participate in the study.

What will happen to me if I take part?
If you agree for your child to take part, your child will be assessed on their phonological awareness and reading ability on school premises and will then receive one of three training programmes outlined in the appending letter. This will take part between September-December 2013, and your child will be re-assessed for long term effects of the intervention three months later in March 2014.

What are the possible disadvantages and risks of taking part?
There are no obvious risks associated with this study. I have Criminal Records Bureau clearance and the Head Teacher is supportive of this study. However, you are free to withdraw from the study at any point during the sessions and at any point up until March 2014 by contacting me using the contact details provided at the foot of this letter and quoting the name of your child.

What are the possible benefits of taking part?
This research may help to determine whether training on speech rhythm measures can enhance literacy performance. It may provide valuable insights into the ways in which reading skills are taught in schools, and may provide alternative methods for those who do not respond to traditional methods.

What if something goes wrong?
This project has been carefully designed and we do not anticipate any mishaps. However, you are free to withdraw from the study at any point during the sessions and at any point up

until March 2014 by contacting me using the contact details provided and quoting the name of your child.

Will my taking part in this study be kept confidential?
Yes. Only I will have access to the raw data. All data gathered from this research will remain confidential and untraceable to yourself and any individual child. It will also be kept in a secure filing cabinet at Coventry University. I will only retain the raw data from the project until my final mark for my research has been given. They will then be destroyed. When the data has been entered into a computer file, scores will only be associated with a code number and I will be the only one who has access to this file.

What will happen to the results of the research study?
The results will be written up and presented as part of my PhD research project. Results may also be presented at academic conferences and/or written up for publication in academic journals.

Who is organising and funding the research?
The research is organised by myself, Emily Harrison, a PhD research student at the Coventry University, in relation to the Psychology and Behavioural Sciences Department. This project is externally funded by the Leverhulme Trust.

Who has reviewed the study?
The Coventry University Ethics Committee has reviewed and approved this study.

Contact for Further Information
If you would like to find out more about this study, please contact me via e-mail at harris86@uni.coventry.ac.uk. You may also contact my Director of Studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk.

Appendix 25: Parental Opt-Out Consent Form – Study 2

Consent form: Return to School to OPT-OUT of participation

Please **read Part A,** then **fill in Part B** if you **DO NOT** wish your child to take part, and return this section (A and B) to the secretary at your child's school at your earliest convenience

You may tear off Part C and keep it for your own records.

Part A

As noted, this study involves administering a set of training materials to your child within their school environment. If you agree for your child to take part, they will be randomly allocated to one of three groups and will receive either a speech rhythm-based training programme (teaching them about stress, intonation and timing in language), a traditional phonics based training programme (teaching them about speech sounds), or a semantic-based training programme (teaching them about word meanings and vocabulary). You are able to withdraw from this study at any point up until March 2014. If you do decide to withdraw your data, please contact me using the contact details provided in Part C and quote the name of your child.

This study is conducted in line with the Code of Conduct, Ethical Principles and Guidelines set out by the British Psychological Society and has already received approval from the Coventry University Ethics Committee.

If you wish for your child to participate, no further action is required.

However, if you **DO NOT** wish for your child to take part, please fill in you details below and return the form to school at your earliest convenience and no later than **Date**

Part B

In signing below, I have considered the benefits of participation in this study but **DO NOT** wish for my child to take part.

Please provide the following details.

Child's full name: ______________________________ Child's class: _____________

Your full name: _________________________________ (Parent/Guardian)

Your signature: ______________________________ Date:__________ (DD/MM/YYYY)

Part C

You may tear off this section (part C) and keep it for your own records.

Thank you for considering participation in this study which aims to investigate whether a set of speech rhythm-based training materials can eliminate the deficit in prosodic sensitivity and enhance reading performance in struggling readers. There are no consequences to deciding that you do not want your child to take part. If you have any further queries regarding the research, please contact me via e-mail at harris86@uni.coventry.ac.uk You may also contact my director of studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk

Yours Faithfully, *Emily Harrison*

Appendix 26: Participant Briefing Form – Study 2

To be read to Year 3 children

Hello (Name)

My name is Emily and today I would like to play some reading games with you. There are 3 different activities in total and this should last about 15 minutes. Then I will come back another day and if you still want to play then we can play the games again. After we have played the games today you can return to class. The Head Teacher of your school and your parents/guardians are happy for me to work on these reading activities with you.

Would you like to work on these reading activities with me? YES/NO

Soon we will start the reading games. If at any point during the activities you feel that you no longer want to do them and that you would prefer to return to class simply say STOP and we will stop and go back to class. Neither me or mr/mrs/miss [teacher's name] will be cross or upset of you decide that you want to stop playing the games.

Do you have any questions before we start?

Appendix 27: Debriefing Letter to Head Teacher – Study 2

Emily Harrison
PhD Research Student
Department of Psychology and Behavioural Sciences
Coventry University
Priory Street
Coventry
CV1 5FB
Tel: 02476 88 8759
Mob: 07854209075
e-mail: harris86@uni.coventry.ac.uk

[Date]

Dear Head Teacher

In [dates of study], your school participated in a research project which investigated whether a set of speech rhythm-based training materials could eliminate the deficit in speech rhythm sensitivity (knowledge and awareness of elements of speech such as stress, intonation and timing) and enhance reading performance in a group of year 3 pupils who were falling behind on their reading performance. We would like to thank you for your kind participation.

Reminder of the purpose of this project

This project aimed to discover whether a set of speech rhythm-based reading intervention could eliminate the deficit in speech-rhythm sensitivity as a possible way of enhancing reading performance in struggling readers.

What we found
Add.

If you would like to discuss the findings of this study in more detail, please contact me via telephone on 07854209075, or via e-mail at harris86@uni.coventry.ac.uk. You may also contact my Director of Studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk.

Yours Faithfully,

Emily Harrison

Appendix 28: Debriefing Letter to Parents – Study 2

Emily Harrison
PhD Research Student
Department of Psychology and Behavioural Sciences
Coventry University
Priory Street
Coventry
CV1 5FB
Tel: 02476 88 8759
Mob: 07854209075
e-mail: harris86@uni.coventry.ac.uk

[Date]

Dear Parents/ Guardians

In [dates of study], your child participated in a research project which investigated whether a set of prosody based training materials could eliminate the deficit in speech rhythm sensitivity (knowledge and sensitivity to elements of language such as stress, intonation and timing in speech) and enhance reading performance. We would like to thank you for your child's participation.

Reminder of the purpose of this project

This project aimed to discover whether a set of speech rhythm-based reading intervention could eliminate the deficit in speech-rhythm sensitivity as a possible way of enhancing reading performance.

What we found
Add.

If you would like to discuss the findings of this study in more detail, please contact me via telephone on 07854209075, or via e-mail at harris86@uni.coventry.ac.uk. You may also contact my Director of Studies (Professor Clare Wood) on 02476 88 8226, or via e-mail at c.wood@coventry.ac.uk.

Yours Faithfully,

Emily Harrison

Appendix 29: Certificate of Participation for Children

Appendix 30: British Ability Scales Single Word Reading Sub-Test Score Sheet

WORD READING B

Materials	Suggested Starting Points	Administration Points	Decision Points
• Word Reading Card B	Ages 5:00–7:11 Item 1 Ages 8:00–10:11 Item 21 Ages 11:00–13:11 Item 41 Ages 14:00–17:11 Item 51	Instructions are on page 369 of the *Administration and Scoring Manual.* / = phonemes // = syllables **bold** = accented syllable	8 failures in a block of 10 words, **stop.** If fewer than 3 passes overall, **go back** to previous Starting Point if applicable.

Start	Item	Response	Score 0–1
5:00–7:11	1	the th/uh	
	2	up u/p	
	3	he h/ee	
	4	you y/oo	
	5	box b/o/ks	
	6	at a/t	
	7	said s/e/d	
	8	out ow/t	
	9	jump j/uh/m/p	
	10	fish f/i/sh	
	11	one w/uh/n	
	12	cup k/uh/p	
	13	wood w/-oo-/d *	
	14	bird b/ur/d	
	15	clock kl/o/k	
	16	ring r/i/ng	
	17	water **w/au**//t/uh	
	18	window **w/i/n**//d/oh	
	19	men m/e/n	
	20	light l/iy/t	
8:00–10:11	21	oil oi/l	
	22	ship sh/i/p	
	23	running **r/uh**//**n**/i/ng	
	24	dig d/i/g	
	25	money m/uh//**n/ee**	
	26	paper **pay**//p/uh	
	27	gate g/ay/t	
	28	knock n/o/k	
	29	heel h/ee/l	
	30	skin sk/i/n	

* -oo- as in look

Start	Item	Response	Score 0–1
	31	coat k/oh/t	
	32	carpet **k/ar**//pit	
	33	brick br/i/k	
	34	thin th/i/n	
	35	building **b/i/l/d**//i/ng	
	36	tail t/ay/l	
	37	travel **t/r/a/v**//uh/l	
	38	babies **b/ay**//b/ee/z	
	39	writing **r/iyt**//i/ng	
	40	climb kl/iy/m	
11:00–13:11	41	collect k/uh//**le/c/t**	
	42	early **ur**//l/ee	
	43	piece p/ee/s	
	44	piano p/ee//**a/n**//oh	
	45	whistle **hw/i/s**//uh/l	
	46	invite i/n//**viyt**	
	47	guest g/e/st	
	48	electric i//**l/e/k**//t/r/i/k	
	49	enormous i//**n/o/r**//m/uh/s	
	50	shoulder **sh/oh/l**//d/uh	
14:00–17:11	51	wreck r/e/k	
	52	favour **f/ay/v**//uh	
	53	supplies s/uh//**pl/iy/z**	
	54	encounter e/n//**k/ow/n**//t/uh	
	55	universal y/oo//n/i//**v/ur**//s/uh/l	
	56	ceiling **s/ee/l**//i/ng	
	57	generation j/e/n//uh//**r/ay**//sh/uh/n	
	58	environment en//**v/iy/r**//uh/n//m/uh/nt	
	59	cough k/o/f	
	60	character **k/a/r**//uh/k//t/uh	

18

WORD READING B (continued)

WORD READING B (continued)

Item	Response	Score 0–1
61	avenue **a/v**//uh//ny/oo	
62	experience eks//**p/ee/r**//i/y//uh/n/s	
63	radiant **r/ay**//d/ee//uh/nt	
64	statue **stach**//yoo	
65	audience **au**//d/ee//uh/n/s	
66	curiosity k/y/oo/r//ee//**o/s**//i//t/ee	
67	obscure o/b//**sk/y/oo/r**	
68	diameter d/i/y//**am**//i//t/uh	
69	chaos **k/ay**//o/s	
70	boisterous **b/oi**//st/r/uh/s	
71	tentative **t/e/n**//t/uh//t/i/v	
72	trauma **trau**//m/uh	
73	jeopardy **j/e/p**//uh//d/ee	
74	silhouette **s/i/l**//oo//w/e/t	
75	desultory **d/e/s**//uh/l//t/r/ee	
76	reminiscent r/e/m//i/**n/i/s**//uh/nt	
77	divulge d/iy//**v/uh/l/j**	
78	diplomacy d/iy//**pl/oh**//m/uh//s/ee	
79	rheumatism **r/oo**//m/uh//t/i/z//uh/m	
80	tyrannical t/i//**r/a/n**//i/k//uh/l	
81	catastrophe k/uh//**t/a/s**//t/r/uh//f/ee	
82	regurgitate r/ee//**g/ur**//j/i//t/ay/t	
83	meticulous m/uh//**t/i/k**//y/uh//l/uh/s	
84	initiate i//**n/i/sh**//ee//ay/t	
85	tertiary **tur**//sh/uh//r/ee	
86	criterion kr/iy//**t/ir**//ee//uh/n	
87	archaic a/r//**k/ay**//i/k	
88	monosyllabic m/o/n//uh//s/uh//**l/a/b**//ik	
89	mnemonic n/e//**m/o/n**//i/k	
90	facetious f/uh//**s/ee**//sh/uh/s	

Total raw score	
Items administered	to

Appendix 31: Diagnostic Test of Word Reading Processes

Score Sheet

Diagnostic Test of Word Reading Processes

Record Form

	Year	Month	Day
Test Date			
Birth Date			
Age at testing			

(Disregard the days for age at testing)

Name:	Gender: ☐ male ☐ female
School/Class:	Year Group:
Tester:	
First Language: ☐ English ☐ Other (please specify):	

Comments/Test observations:

Record of scores

Raw scores to stanines

	Raw score	Stanine
Non-word Reading		
Exception Word Reading		
Regular Word Reading		

Total raw score to standard score

		95% confidence intervals
Total raw score:		
Standard score:		to
Percentile rank:		to
Age equivalent:	yrs mths	

Pupil Profile Table

Exception Word Reading stanine score	Non-word Reading stanine score: 1	2	3	4	5	6	7	8	9
1	M	M	L-S	L-S	L-S	L-S	L-S	L-S	L-S
2	M	M	M	L-S	L-S	L-S	L-S	L-S	L-S
3	P	M	M	M	L-S	L-S	L-S	L-S	L-S
4	P	P	M	M	M	L-S	L-S	L-S	L-S
5	P	P	P	M	M	M	L-S	L-S	L-S
6	P	P	P	P	M	M	M	L-S	L-S
7	P	P	P	P	P	M	M	M	L-S
8	P	P	P	P	P	P	M	M	M
9	P	P	P	P	P	P	P	M	M

GL assessment
the measure of potential

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Non-word Reading

Discontinuation rule: stop testing after 5 consecutive errors

Practice items	A. ud [thud]	B. heg [peg]

Item	Response	Score (circle)	Acceptable pronunciations
1. un		1 0 NR	[sun]
2. wup		1 0 NR	[up, put]
3. wem		1 0 NR	[them]
4. mon		1 0 NR	[gone]
5. keet		1 0 NR	[meet]
6. mave		1 0 NR	[gave]
7. thent		1 0 NR	**th** [that, thumb] – **ent** [went]
8. sade		1 0 NR	[made]
9. dragell		1 0 NR	**drag** [drag] – **ell** [bell, table]
10. pertle		1 0 NR	[turtle]
11. sus		1 0 NR	[fuss]
12. gouse		1 0 NR	[mouse]
13. netrich		1 0 NR	**net** – **rich**
14. piclin		1 0 NR	**pic** [pick] – **lin** [bin]
15. gobner		1 0 NR	**gob** [gob] – **ner** [her, sofa]
16. cortue		1 0 NR	**cor** [bore] – **tue** [chew, t+you]
17. turmness		1 0 NR	**turm** [term] – **ness** [mess]
18. chimpister		1 0 NR	**chimp** [chimp] – **ister** [mister]
19. stroise		1 0 NR	[noise]
20. marzentrate		1 0 NR	**marz** [mars] – **en** [pen, open] – **trate** [grate]
21. statnic		1 0 NR	**stat** [hat] – **nic** [nick]
22. banifice		1 0 NR	**ban** [ban] – **i** [sit, see] – **fice** [nice or miss]
23. sacranzee		1 0 NR	**sac** [sack] – **ran** [ran] – **zee** [tree]
24. anecoil		1 0 NR	**an** [an] – **e** [pen, pin, see, sofa] – **coil** [coil]
25. audimental		1 0 NR	**ord** [lord] – **i** [sit, see, sofa] – **men** [men] – **tal** [shall, mettle]
26. concipan		1 0 NR	**kon** [on] – **si** [sip, see] – **pan** [pan]
27. wilderdote		1 0 NR	**wil** [will, while] – **der** [her, sofa] – **dote** [coat, cot]
28. ostant		1 0 NR	**o** [pot, oh] – **stant** [ant]
29. elephaps		1 0 NR	**el** [bell] – **e** [bell, sofa, it, see] – **faps** [caps]
30. experorium		1 0 NR	**ex** [next] – **per** [her, error] – **orium** [auditorium]
Non-word Reading raw score			

Exception Word Reading

Discontinuation rule: stop testing after 5 consecutive errors

Item	Response	Score (circle)
1. his		1 0 NR
2. come		1 0 NR
3. ball		1 0 NR
4. some		1 0 NR
5. who		1 0 NR
6. there		1 0 NR
7. monkey		1 0 NR
8. half		1 0 NR
9. ghost		1 0 NR
10. know		1 0 NR
11. many		1 0 NR
12. sugar		1 0 NR
13. want		1 0 NR
14. giant		1 0 NR
15. island		1 0 NR
16. station		1 0 NR
17. soup		1 0 NR
18. cousin		1 0 NR
19. machine		1 0 NR
20. stomach		1 0 NR
21. vehicle		1 0 NR
22. restaurant		1 0 NR
23. parachute		1 0 NR
24. reservoir		1 0 NR
25. mosquito		1 0 NR
26. sovereign		1 0 NR
27. treacherous		1 0 NR
28. horizon		1 0 NR
29. speciality		1 0 NR
30. miscellaneous		1 0 NR
	Exception Word Reading raw score	

Regular Word Reading

Discontinuation rule: stop testing after 5 consecutive errors

Item	Response	Score (circle)
1. up		1 0 NR
2. sun		1 0 NR
3. them		1 0 NR
4. went		1 0 NR
5. us		1 0 NR
6. made		1 0 NR
7. dragon		1 0 NR
8. well		1 0 NR
9. mouse		1 0 NR
10. gave		1 0 NR
11. elephant		1 0 NR
12. street		1 0 NR
13. corner		1 0 NR
14. kettle		1 0 NR
15. noise		1 0 NR
16. ostrich		1 0 NR
17. chimpanzee		1 0 NR
18. picnic		1 0 NR
19. perhaps		1 0 NR
20. goblin		1 0 NR
21. banister		1 0 NR
22. statue		1 0 NR
23. marzipan		1 0 NR
24. experimental		1 0 NR
25. turmoil		1 0 NR
26. concentrate		1 0 NR
27. sacrifice		1 0 NR
28. wilderness		1 0 NR
29. auditorium		1 0 NR
30. anecdote		1 0 NR
	Regular Word Reading raw score	

Appendix 32: York Assessment of Reading Comprehension Passage Reading Score Sheet

YARC

Pupil Record Form: Form B

York Assessment of Reading for Comprehension: Passage Reading

Name/ID:		
Gender:	boy	girl
Language(s) at home:		
School/Class:		
Year Group:		
Tester:		

	Year	Month	Day
Test date			
Birth date			
Chronological age			

Comments/Test observations:

Recommendations/Next steps:

Raw scores and conversion to ability scores

	Reading Accuracy		Reading Rate			Comprehension	
Form B Passage level	Number of Errors	Ability score	Time taken	Time Category	Ability score	Comp score Passage 1	Comp score Passage 2
Beginner: Postcard from Grandma							
Level 1: First day at school – 63 words							
Level 2: Cats – 95 words							
Level 3: Missing handbag – 155 words							
Level 4: Bees – 179 words							
Level 5: Walk in the fog – 187 words							
Level 6: Shoes – 230 words							
						Total raw score (passage 1 + 2)	
	Average ability score		Average ability score			Paired ability score	

Time Category = $\frac{\text{Number of words in passage}}{\text{Time taken (in seconds)}} \times 5$ Round to nearest whole number

Time Category passage 1 = ———— × 5 = Time Category passage 2 = ———— × 5 =

Average ability score = $\frac{\text{Total ability score}}{2}$ Calculate separately for Reading Accuracy and Reading Rate

For Level 1 only. If the pupil **exceeded** the maximum number of reading errors, record the number of reading errors and comprehension score. Do **not** include Reading Rate.

For all other levels, do **not** include the scores from passages where the pupil **exceeded** the maximum number of reading errors.

Standard scores

	Ability score	Standard score	Percentile rank	Age equivalent
Accuracy				yrs mths
Rate				yrs mths
Comprehension				yrs mths

Analysis of reading errors

	Mispronunciations	Substitutions	Refusals	Additions	Omissions	Reversals	Total error count
Total error type (summed across passages)							
*% of total errors							

*% of total errors = $\frac{\text{Total error type}}{\text{Total error count}} \times 100$

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Beginner Level Form B: Postcard from Grandma

Discontinuation rule: Stop after **15** reading errors

Assessor:	Sam hurried downstairs early one Tuesday morning.
Child:	There was a postcard on the door mat.
Assessor:	On the front was a picture of an old stone castle.
Child:	Sam picked it up. "Can you read it mum?" he said.
Assessor:	I am glad I packed my umbrella. Love from Grandma.
Child:	"I wish I was on holiday," said Sam.

						PASSAGE TOTALS
						Reading accuracy
Mispronunciations	Substitutions	Refusals	Additions	Omissions	Reversals	**Number of errors**

Child – 27 words
Assessor – 28 words

Question	**Child's response**	**Score**
1. Where was the postcard?		1 0 NR
2. Who was the postcard from?		1 0 NR
3. What did Grandma visit?		1 0 NR
4. Who picked up the postcard?		1 0 NR
5. Who read the postcard?		1 0 NR
6. What was the weather like on Grandma's trip?		1 0 NR
7. What was Grandma pleased that she had packed?		1 0 NR
8. What did Sam wish?		1 0 NR
	Comprehension Score	

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Level 1 Form B: First day at school

Only record the time taken if the pupil makes 15 or fewer reading errors

It was Poppy's first day at school and she was feeling a bit worried. The school bell rang and she went inside. Poppy's teacher, Miss Frost, was waiting at the door. Poppy hung her hat on her peg and went into the classroom. There were red, green and yellow paints on the tables. She saw her friend Mark and began to feel better.

						PASSAGE TOTALS	
						Reading accuracy	Reading rate
Mispronunciations	Substitutions	Refusals	Additions	Omissions	Reversals	Number of errors	Time taken (seconds)

63 words

Question	Child's response	Score
1. Why was it a special day?		1 0 NR
2. How did Poppy feel at the start of the story?		1 0 NR
3. When did Poppy go into the school?		1 0 NR
4. What was Poppy's teacher doing?		1 0 NR
5. What did Poppy hang on her peg?		1 0 NR
6. What do you think that the first lesson was going to be?		1 0 NR
7. Who did Poppy see in the classroom?		1 0 NR
8. Why do you think that Poppy began to feel a bit better?		1 0 NR
	Comprehension Score	

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Level 2 Form B: Cats

Discontinuation rule: Stop after **15** reading errors

Big cats and house cats all have fur, whiskers, a tail and claws. They belong to the same family of animals.

Big cats such as lions and tigers live in the wild. They can roar but they do not purr. They feed themselves by hunting and eating large animals like deer and zebras. Their young are called cubs.

House cats make good pets because they are tame. They cannot roar but they do purr. Their owners feed them but they may still hunt small animals such as birds and mice. Their young are called kittens.

						PASSAGE TOTALS	
						Reading accuracy	**Reading rate**
Mispronunciations	Substitutions	Refusals	Additions	Omissions	Reversals	**Number of errors**	**Time taken (seconds)**

95 words

Question	**Child's response**	**Score**
1. What kind of food do all cats eat?		1 0 NR
2. What does it mean when it says that big cats live in the wild?		1 0 NR
3. From this passage, tell me one animal that is eaten by big cats.		1 0 NR
4. What are the young of big cats called?		1 0 NR
5. What can a big cat do that house cats cannot do?		1 0 NR
6. Which type of cat has kittens?		1 0 NR
7. Big cats and house cats both have fur. Tell me something else that is the same about them.*		1 0 NR
8. According to the passage, why do house cats make good pets?		1 0 NR

* If the child says eat meat or hunt, ask for another thing that is the same.

Comprehension Score	

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Level 3 Form B: Missing handbag

Discontinuation rule: Stop after **20** reading errors

It was the first day of Ryan's family holiday. They were staying in a cottage which overlooked the harbour in Peele Bay. It was a glorious sunny day, so the family had wandered down to the beach. Dad volunteered to look after their bags. Mum explored the beach, then joined Ryan and his sister in the foaming waves. Dad relaxed and read his magazine. When mum had had enough of the water, she returned to sit with dad. He had fallen asleep and was scarlet. She glanced around and realised her handbag was missing. It must have been stolen. Mum was furious with dad.

Everyone hurried to the police station. Much to their surprise it had already been handed in and nothing was missing. The policeman said an old lady had found it in the beach toilets. Then mum remembered; she had left it there. Mum apologised to dad and bought him a huge ice-cream.

						PASSAGE TOTALS	
						Reading accuracy	**Reading rate**
Mispronunciations	Substitutions	Refusals	Additions	Omissions	Reversals	**Number of errors**	**Time taken (seconds)**

155 words

Question	**Child's response**	**Score**
1. Where did Ryan and his family go to on holiday?		1 0 NR
2. How do you know that the cottage was close to the beach?		1 0 NR
3. Who played in the sea?		1 0 NR
4. What did dad do?		1 0 NR
5. Why was dad scarlet?*		1 0 NR
6. Why did mum blame dad?		1 0 NR
7. How did the bag get to the police station?		1 0 NR
8. Why do you think mum bought dad an ice-cream?		1 0 NR
	Comprehension Score	

* Do not explain what scarlet means.

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Level 4 Form B: Bees

Discontinuation rule: Stop after **20** reading errors

Does the sight of a bumble bee fill you with dread? It shouldn't: although larger, it is less aggressive than the honey bee and will only attack if threatened. Also, unlike honey bees, bumble bees never form an angry swarm because their nests are small.

After winter hibernation the queen bee constructs a nest in an old mouse hole or leaf litter or, sometimes, under a shed or large stone. Subsequently, she lays the eggs from which female worker bees develop. While the worker bees collect nectar, the queen continues egg laying. From those eggs laid in late summer, male drones and queen bees develop, the drones' sole purpose in life being to mate with the young queens, thus ensuring the survival of the species.

Come the first frosts, the old queen, worker bees and drones die, leaving the young queens to hibernate and await the warmth of spring.

We rely on the bumble bee to pollinate our plants, but with buildings replacing their habitats, and pesticides poisoning their food source, man is the greatest threat to their species.

						PASSAGE TOTALS	
						Reading accuracy	**Reading rate**
Mispronunciations	Substitutions	Refusals	Additions	Omissions	Reversals	**Number of errors**	**Time taken (seconds)**

179 words

Question	**Child's response**	**Score**
1. In what way are bumble bees different from honey bees?		1 0 NR
2. Why do bumble bees never swarm?		1 0 NR
3. Name one type of bumble bee.		1 0 NR
4. Why is the nectar collected by the worker bees?		1 0 NR
5. Why do we need bumble bees?		1 0 NR
6. What is the greatest threat to bumble bees?		1 0 NR
7. How are people affecting bumble bees?		1 0 NR
8. What is meant by 'threat to the species'?		1 0 NR
	Comprehension Score	

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Level 5 Form B: Walk in the fog

Discontinuation rule: Stop after **20** reading errors

Anita stood quite still, transfixed by the repeated sequence of the blue-grey water: the swell, the surge forward, the roaring crash and then the ebb. It reminded her of her fight with her older brother: the build up of petty irritations, the taunting remarks followed by an explosive row, and afterwards, the false calm as they each retreated to brood on real, or imagined, grievances. Sometimes she hated Chris.

As she turned to throw a stick for Patch, she noticed the mist beginning to swirl in; she could no longer make out the pier. A dank murkiness could quickly replace sunshine on this remote northern coast so she decided to head for home. Half way down the beach, she shivered, partly from cold and partly from fear, as the thickening fog isolated her from the rest of the world: even Patch had deserted her. Suddenly, from the depths of the gloom, an arm reached out and a hand gripped her shoulder. Anita could feel her heart racing wildly. Anxiously, she stood rooted to the spot. "Hi sis," said a familiar voice, "I was getting worried about you."

						PASSAGE TOTALS	
						Reading accuracy	**Reading rate**
Mispronunciations	Substitutions	Refusals	Additions	Omissions	Reversals	**Number of errors**	**Time taken (seconds)**

187 words

Question	**Child's response**	**Score**
1. What is the main character called?		1 0 NR
2. What is the 'repeated sequence of the blue-grey water'?		1 0 NR
3. What event had recently taken place?		1 0 NR
4. What does a 'dank murkiness' mean?		1 0 NR
5. How did Anita realise that the mist was coming in?		1 0 NR
6. What two things made Anita shiver?*		1 0 NR
7. Why did Anita's heart race wildly?		1 0 NR
8. How do you know that Anita's brother did care about her?		1 0 NR
	Comprehension Score	

* If the child gives one answer, prompt for a second.

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Level 6 Form B: Shoes

Discontinuation rule: Stop after **20** reading errors

Early shoes similar to sandals might have been created using bark, large leaves and grass, skilfully tied on with vines or reeds. Animal skins may have been cut and hole punched, laced with leather strips and a drawstring strap, and drawn up to produce shoes that enclosed and protected the feet. Sandals worn by Roman soldiers had a criss-crossed lattice and heavily nailed sole. They were ideal for the gruelling marches when conquering European territories.

Footwear clearly has very practical origins but, throughout the centuries, it has also been significant as the wearer's social and fashion statement. In the fourteenth century men wore shoes with long curled toes, the length of which was a clear indicator of a man's wealth and status. They sometimes needed a chain to be attached from the toe to the knee to help them to walk.

Modern day trainers or sneakers (so called because the rubberised sole made the shoes stealthy and quiet when walking) became popular in the late nineteenth century. Trainers were worn by athletes until Hollywood picked up the fashion and made them the official uniform of the young and trendy. At the beginning of the twentieth century Converse began manufacturing the first performance basketball shoes which were closely followed by Adi Dassler's hand-made training shoes. To wear footwear with their logos was a signal of just how fashionable we were!

						PASSAGE TOTALS	
						Reading accuracy	**Reading rate**
Mispronunciations	Substitutions	Refusals	Additions	Omissions	Reversals	**Number of errors**	**Time taken (seconds)**

230 words

Question	**Child's response**	**Score**
1. What might early shoes have been made from?		1 0 NR
2. How were early shoes designed to enclose the foot?		1 0 NR
3. Who went on gruelling marches to conquer European territories?		1 0 NR
4. How has the purpose of footwear changed since the Roman times?		1 0 NR
5. In the 14th century, what part of the shoe was a clear indicator of a man's wealth and status?		1 0 NR
6. Why were trainers also called sneakers?		1 0 NR
7. Who was the first person to produce trainers specialised for sport?		1 0 NR
8. When did Converse begin manufacturing performance basketball shoes?		1 0 NR
	Comprehension Score	

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Appendix 33: Phonological Assessment Battery Rhyme Awareness Sub-Test Score Sheet

Phonological Assessment Battery (PhAB) Record Form

Rhyme Test

Practice items				
A.	sail	boot	nail	
B.	red	fed	leg	
C.	big	hiss	miss	
Part 1 test items				Score 0 or 1
1.	made	hide	fade	
2.	wig	fig	pin	
3.	bus	harm	farm	
4.	pack	lack	sag	
5.	sap	hop	top	
6.	nut	cut	pet	
7.	sand	hand	cup	
8.	cat	fan	mat	
9.	dot	mop	top	
10.	tub	mud	cub	
11.	dog	man	fog	
12.	sip	win	bin	
Part 1 total (9 or more needed to continue)				

Part 2 test items				Score 0 or 1
13.	badge	match	catch	
14.	fate	late	made	
15.	tease	geese	piece	
16.	lip	sip	rib	
17.	dog	sock	log	
18.	had	sad	mat	
19.	lick	big	tick	
20.	bead	wheat	seat	
21.	cob	hop	sob	
Part 2 total				

RHYME TEST TOTAL (Part 1 + Part 2: out of 21)	

Comments:

Appendix 34: Phonological Assessment Battery

Alliteration Sub-Test Score Sheet

Alliteration Test

Part 1 practice items				
A. shop	mat	shell	(sh)	
B. lot	mess	mud	(m)	
C. pick	pat	run	(p)	
Part 1 test items				Score 0 or 1
1. ship	fat	fox	(f)	
2. mug	zip	men	(m)	
3. bike	name	nose	(n)	
4. dig	dot	pen	(d)	
5. tin	sack	top	(t)	
Part 1 total (3 or more needed to continue)				

Part 2 practice items				
D. plum	crane	cloud	(c)	
E. brain	bleed	school	(b)	
Part 2 test items				Score 0 or 1
6. snake	clap	crawl	(c)	
7. plate	pram	draw	(p)	
8. sleep	clown	snail	(s)	
9. cross	twig	truck	(t)	
10. drip	skirt	dwarf	(d)	
Part 2 total				

ALLITERATION TEST TOTAL (Part 1 + Part 2: out of 10)	

Supplementary Test: Alliteration Test with Pictures

Part 1 practice items				
A. road	light	rain	(r)	
B. well	peg	pot	(p)	
Part 1 test items				Score 0 or 1
1. sun	lid	sock	(s)	
2. jam	jug	bed	(j)	
3. ten	bus	tap	(t)	
4. web	lamb	leg	(l)	
5. man	mop	dish	(m)	
Part 1 total (3 or more needed to continue)				

Part 2 practice items				
C. slide	blot	scale	(s)	
D. blouse	brush	glass	(b)	
Part 2 test items				Score 0 or 1
6. stool	square	plant	(s)	
7. glove	brick	grass	(g)	
8. dress	flame	frog	(f)	
9. pram	fly	plug	(p)	
10. spade	crab	clock	(c)	
Part 2 total				

ALLITERATION TEST WITH PICTURES TOTAL (Part 1 + Part 2: out of 10)	

Comments:

Appendix 35: Phonological Assessment Battery

Spoonerisms Sub-Test Score Sheet

Spoonerisms Test

Part 1 practice items					
A.	cat	with a /f/	gives	(fat)	
B.	lip	with a /t/	gives	(tip)	
C.	dog	with a /l/	gives	(log)	
Part 1 test items (Discontinue after three minutes)					**Score 0 or 1**
Time starts → 1.	cot	with a /g/	gives	(got)	
2.	fun	with a /b/	gives	(bun)	
3.	red	with a /b/	gives	(bed)	
4.	go	with a /s/	gives	(so)	
5.	might	with a /f/	gives	(fight)	
6.	make	with a /t/	gives	(take)	
7.	need	with a /st/	gives	(steed)	
8.	gaze	with a /cr/	gives	(craze)	
9.	stoke	with a /br/	gives	(broke)	
10.	crime	with a /ch/	gives	(chime)	
Part 1 total (out of 10)					

Part 2 practice items				
D.	King John	gives	(Jing Kon)	
E.	lazy dog	gives	(daisy log)	
F.	snow black	gives	(blow snack)	
Part 2 test items (Discontinue after three minutes)				**Score 0, 1 or 2**
Time starts → 1.	sad cat	gives	(cad sat)	
2.	big pip	gives	(pig bip)	
3.	fed man	gives	(med fan)	
4.	boast core	gives	(coast bore)	
5.	riding boot	gives	(biding root)	
6.	float down	gives	(dote floun)	
7.	prickley man	gives	(mickly pran)	
8.	which brute	gives	(britch woot)	
9.	crowded ship	gives	(shouded crip)	
10.	plane crash	gives	(crane plash)	
Part 2 total (out of 20)				

SPOONERISMS TEST TOTAL (Part 1 + Part 2: out of 30)	

Comments:

Illegal photocopying is theft and may result in prosecution

Appendix 36: Speech Rhythm Sensitivity Assessment:

Pre-test Score Sheet

PRE-TEST ASSESSMENT

Name: ……………………………. Date: …………………………

Stress Items	√ / x	Comments
Rabbit*		
Television		
Computer*		
Trumpet*		
Finger		

Intonation Items	√ / x	Comments
Raining outside?		
Monday today?		
Bedtime		
Play on the Computer		
Gingerbread?		

Timing Items	√ / x	Comments
Jellyfish (1)		
Foot Ball (2)		
Key Ring (2)		
Twenty one (1)		
Sun Flower (2)		

Appendix 37: Speech Rhythm Sensitivity Assessment:

Post-test Score Sheet

POST-TEST ASSESSMENT

Name: ……………………………… Date: ………………………

Stress Items	√ / x	Comments
Teddy		
Vegetables*		
Cupcake		
Shower*		
Balloon*		

Intonation Items	√ / x	Comments
Cup of tea?		
Having fun?		
Look out the window		
Eat your fruit		
Go swimming?		

Timing Items	√ / x	Comments
Jelly Baby (2)		
Wheel Chair (2)		
Blackbird (1)		
Cupcake (1)		
Ice Lolly (2)		

Appendix 38: Speech Rhythm Sensitivity Assessment:

Delayed Post-test Score Sheet

DELAYED POST-TEST ASSESSMENT

Name: ………………………………… Date: …………………………

Stress Items	√ / x	Comments
Rabbit		
Television*		
Computer		
Trumpet		
Finger*		

Intonation Items	√ / x	Comments
Raining outside		
Monday today		
Bedtime?		
Play on the computer?		
Gingerbread		

Timing Items	√ / x	Comments
Jelly Fish (2)		
Football (1)		
Keyring (1)		
Twenty One (2)		
Sunflower (1)		

Appendix 39: British Picture Vocabulary Scales III Score Sheet

BPVS III

Performance Record

British Picture Vocabulary Scale: Third Edition

Surname: ______ First name: ______ Sex: ☐ M ☐ F

School: ______ Teacher: ______

Home address: ______

Tel: ______

Referral source / person requesting testing:

______

Reason for testing:

☐ Achievement test of hearing vocabulary

☐ Other ______

First language: ☐ English ☐ Other

Disability: ☐ None ☐ Suspected ☐ Confirmed

Type (if any): ______

(Specify: hearing / vision loss, speech / language deficits, etc.)

Dates	Year	Month	Day
Date of testing	___	___	___
Date of birth	___	___	___
Age in years and completed months	___	___	

Record of scores

		Confidence bands		
		SS−9		SS+9
Raw score:	⬠			
Standardised score:	☐ (From Norm Table A)	☐	to	☐
Percentile rank:	☐ (From Norm Table B)	☐	to	☐
Age equivalent:	☐ (From Norm Table C)	☐	to	☐

Please see Manual for details of Calculation and Interpretation (pages 10–13)

GL assessment
the measure of potential

Administering the test items

Before administering the actual test items, it is essential to:

1) Read pages 5 to 10 of the Manual.
2) Use the training plates as directed (instructions are in the Testbook on the administrator's side of the training plates).

Where to start the test

For a subject assumed to be of average ability, find the set corresponding with the student's age and begin the test with the first word in that set. In other circumstances consult the Manual. Once you begin a set, always administer every item in that set.

How to establish the Basal Set

The Basal Set is the set where no more than one error is made. Begin from the Start Set, according to age. If no more than one error is made, this set is the Basal Set. If more than one error is made, find the Basal Set by testing backwards through preceding sets until no more than one error is made in a set.

How to establish the Ceiling Set

Only after the Basal Set has been established, test forward by sets until eight or more responses are wrong in a set of 12 items. This is the Ceiling Set. (Do not re-test previously administered sets which were used when establishing the Basal Set).

How to record the responses and errors

As shown below, record the student's responses for each item administered in the 'Response given' column. If the response is incorrect draw an oblique line through the adjacent circle. Otherwise, leave it blank. Use the abbreviations DK for Don't Know and NR for No Response.

E.g:

12	money	(3)	4 ∅

Upon completion of each set, record the number of wrong responses in the space provided.

REMEMBER THESE RULES:

- Once a set is started, always administer *all 12 items* in that set.
- The Basal Set rule is *one or no errors* in a set.
- The Ceiling Set rule is *eight or more errors* in a set.

Set 1	**Start – Ages 2–3**	**Correct response**	**Response given**
1	ball	(3)	○
2	duck	(3)	○
3	mouth	(1)	○
4	jumping	(3)	○
5	spoon	(1)	○
6	circle	(4)	○
7	drinking	(1)	○
8	cat	(2)	○
9	apple	(4)	○
10	blue	(2)	○
11	swimming	(4)	○
12	money	(3)	○
			No. of errors

Set 2	**Start – Age 4**	**Correct response**	**Response given**
13	toe	(4)	○
14	fire	(1)	○
15	aeroplane	(1)	○
16	tortoise	(1)	○
17	belt	(3)	○
18	farmer	(3)	○
19	thumb	(1)	○
20	castle	(2)	○
21	empty	(2)	○
22	fence	(3)	○
23	tunnel	(2)	○
24	happy	(3)	○
			No. of errors

Set 3		Correct response	Response given
25	dancing	(3)	
26	panda	(1)	
27	whistle	(1)	
28	dressing	(3)	
29	nest	(4)	
30	ruler	(1)	
31	hopping	(1)	
32	mountain	(2)	
33	hook	(4)	
34	calendar	(4)	
35	juggling	(4)	
36	rectangle	(2)	
			No. of errors

Set 4	Start – Ages 5–6	Correct response	Response given
37	ring	(4)	
38	fountain	(3)	
39	branch	(4)	
40	elbow	(4)	
41	sawing	(3)	
42	gigantic	(4)	
43	sharing	(2)	
44	diamond	(1)	
45	zip	(2)	
46	feather	(1)	
47	spanner	(3)	
48	globe	(2)	
			No. of errors

Set 5	Start – Age 7	Correct response	Response given
49	diving	(2)	
50	target	(2)	
51	delivering	(4)	
52	desk	(3)	
53	jogging	(4)	
54	binoculars	(3)	
55	astronaut	(3)	
56	map	(3)	
57	jewellery	(1)	
58	measuring	(1)	
59	terrified	(3)	
60	chimney	(4)	
			No. of errors

Set 6	Start – Age 8	Correct response	Response given
61	tearing	(4)	
62	package	(3)	
63	rough	(3)	
64	violin	(1)	
65	chef	(1)	
66	floating	(3)	
67	harp	(1)	
68	ankle	(4)	
69	dripping	(4)	
70	vehicle	(4)	
71	sorting	(1)	
72	brain	(2)	
			No. of errors

Set 7	Start – Ages 9–11	Correct response	Response given
73	island	(1)	
74	waistcoat	(3)	
75	tugging	(2)	
76	pelvis	(2)	
77	avocado	(1)	
78	banister	(2)	
79	tubular	(1)	
80	pillar	(2)	
81	grooming	(4)	
82	hyena	(4)	
83	canoe	(2)	
84	hive	(1)	
			No. of errors

Set 8		Correct response	Response given
85	towing	(1)	
86	links	(2)	
87	adjustable	(2)	
88	funnel	(2)	
89	valley	(1)	
90	greeting	(1)	
91	solo	(4)	
92	harvesting	(1)	
93	antlers	(3)	
94	tropical	(2)	
95	currency	(3)	
96	hurdling	(3)	
			No. of errors

Set 9	Start – Ages 12–13	Correct response	Response given
97	fictional	(1)	○
98	luggage	(2)	○
99	applauding	(3)	○
100	inflated	(3)	○
101	arctic	(2)	○
102	hovering	(1)	○
103	pedestrian	(3)	○
104	snarling	(2)	○
105	exhausted	(2)	○
106	construction	(2)	○
107	aquarium	(1)	○
108	beaker	(3)	○
			No. of errors

Set 10	Start – Ages 14+	Correct response	Response given
109	canine	(1)	○
110	clamp	(1)	○
111	parallel	(4)	○
112	bouquet	(2)	○
113	polluting	(3)	○
114	valve	(3)	○
115	illumination	(4)	○
116	nutritious	(3)	○
117	departing	(3)	○
118	trowel	(4)	○
119	escorting	(4)	○
120	wedge	(4)	○
			No. of errors

Set 11		Correct response	Response given
121	archaeologist	(1)	○
122	duet	(1)	○
123	fungus	(3)	○
124	hoisting	(1)	○
125	foundation	(1)	○
126	rodent	(3)	○
127	interior	(1)	○
128	citrus	(2)	○
129	feline	(2)	○
130	coast	(4)	○
131	detonation	(2)	○
132	embracing	(3)	○
			No. of errors

Set 12		Correct response	Response given
133	garment	(4)	○
134	capsules	(4)	○
135	aviation	(1)	○
136	consuming	(3)	○
137	primate	(1)	○
138	ascending	(2)	○
139	beverage	(1)	○
140	goblet	(4)	○
141	tuba	(1)	○
142	carpenter	(2)	○
143	appliance	(1)	○
144	incisor	(3)	○
			No. of errors

Set 13		Correct response	Response given
145	lever (**lee**-vuh)	(2)	○
146	oasis (**oh**-**ay**-sis)	(4)	○
147	talon (**ta**-luhn)	(3)	○
148	lubricating (**loo**-bri-kayt-ing)	(1)	○
149	easel (**ee**-zuhl)	(4)	○
150	angler (**ang**-luh)	(1)	○
151	perplexed (puhr-**pleksd**)	(2)	○
152	cultivating (**kul**-ti-vayt-ing)	(1)	○
153	maritime (**ma**-ri-tiym)	(1)	○
154	culinary (**kul**-in-uh-ree)	(3)	○
155	sedan (suh-**dan**)	(1)	○
156	marsupial (mahr-**soo**-pyuhl)	(4)	○
			No. of errors

Set 14		Correct response	Response given
157	fowl (**faul**)	(4)	○
158	encumbered (en-**kum**-buhd)	(3)	○
159	castor (**kah**-stuh)	(3)	○
160	bovine (**boh**-viyn)	(1)	○
161	replenishing (re-**plen**-ish-ing)	(3)	○
162	convex (**con**-veks)	(1)	○
163	embossed (em-**bosd**)	(2)	○
164	incarcerating (in-**kah**-suh-rayt-ing)	(2)	○
165	copious (**koh**-pee-uhs)	(2)	○
166	incandescent (in-kan-**des**-uhnt)	(4)	○
167	lacrimation (la-kri-**may**-shuhn)	(1)	○
168	apparel (a-**pa**-ruhll)	(4)	○
			No. of errors

Pronunciation Key
a = short a as in man
e = short e as in leg
i = short i as in bit
o = short o as in dog
u = short u as in bun
ah as in car
au as in out
ay = long a as in day
ee = long e as in feet
iy = long i as in vine
oh = long o as in road
oo = long u as in soup
uh as in father
uhr as in circle

Calculating the raw score

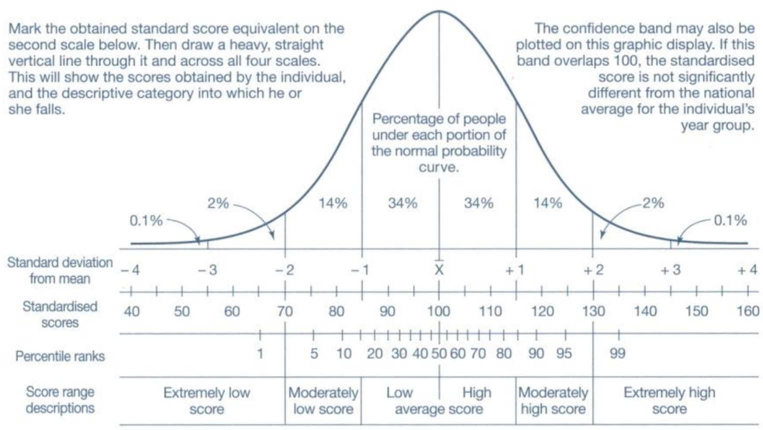
Record the number of the Ceiling Item, which is the last item in the Ceiling Set. Subtract from it the total number of errors made by the student from the Basal Set through to the Ceiling Set. This is the raw score.

Ceiling Item ____________

minus error ____________

Raw score

Graphic Display of Test Results



Results from other tests

Test	Date	Results

Additional information:

____

____

____

Performance Evaluation

Notes and observations

For example, briefly describe the student's test behaviour, such as interest in the task, speed of response, signs of perserveration (repetition of same response to different items), work habits, disabilities, etc.

____

____

____

Do you believe the performance of this student represents fairly his/her true ability in this area?

Yes ☐ No ☐

If not, give reasons.

____

____

____

In testing this student, I certify that I used an original record form, not an illegal reproduction.

______________________________ (Administrator's printed name)

______________________________ (Administrator's signature)

GL assessment
the measure of potential

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Appendix 40: Weschler Abbreviated Scale of Intelligence

Score Sheet

WASI-II Record Form

WECHSLER ABBREVIATED SCALE OF INTELLIGENCE® — SECOND EDITION

Calculation of Examinee's Age	Year	Month	Day
Test Date			
Birth Date			
Test Age			

Examinee Name: ID:

Sex: ☐ F ☐ M Handedness: ☐ R ☐ L

Address/School/Testing Site:

Highest Education/Grade:

Examiner Name:

Total Raw Score to *T* Score Conversion

Subtest	Raw Score	*T* Scores			
Block Design					
Vocabulary					
Matrix Reasoning					
Similarities					
Sum of *T* Scores					
		Verbal Comp.	Perc. Rsng.	Full Scale–4	Full Scale–2

Examinee Visual/Hearing Aids During Testing

Check type of aid examinee needed:	Used	Not Used
☐ Glasses	☐	☐
☐ Prescription Lenses	☐	☐
☐ Assisted Listening Device	☐	☐
☐ Other:	☐	☐

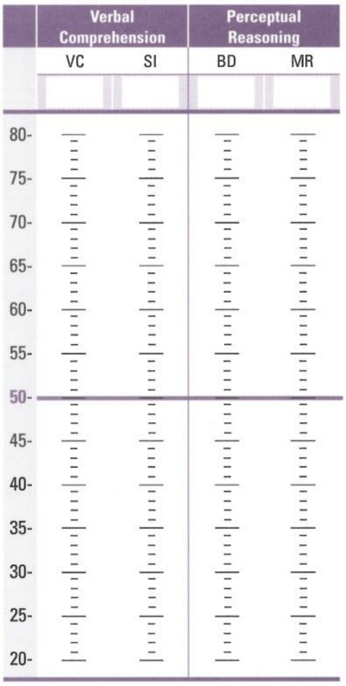
Sum of *T* Scores to Composite Score Conversion

Scale	Sum of *T* Scores	Composite Score		Percentile Rank	Confidence Interval 90% or 95%
Verbal Comp.		VCI			–
Perc. Rsng.		PRI			–
Full Scale–4		FSIQ–4			–
Full Scale–2		FSIQ–2			–

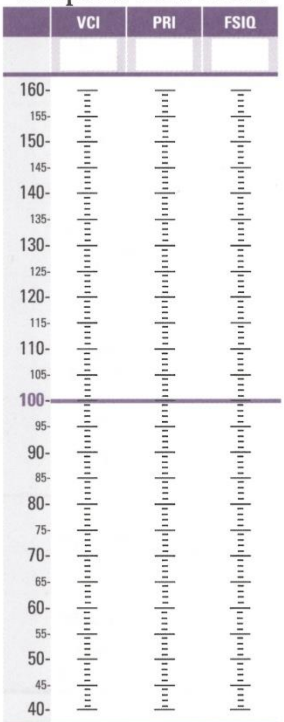
Ranges of Expected Scores

Scores	Confidence Level 90%	68%
FSIQ–4		
WISC–IV FSIQ	–	–
WAIS–IV FSIQ	–	–

Subtest *T* Score Profile



Composite Score Profile



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PsychCorp

1 2 3 4 5 6 7 8 9 10 11 12 A B C D E 282563-1 321

Product Number 0158981596

1. Block Design

(Time limit: See item)

Start
Ages 6–8: Item 1
Ages 9–90: Item 3

Reverse
Ages 9–90: Does not obtain a perfect score on *either* Item 3 or Item 4, administer the preceding items in **reverse** order until two consecutive perfect scores are obtained.

Discontinue
After **2** consecutive scores of 0.

Stop
Ages 6–8: After Item 11.

Record & Score
Items 1–4: Score **0**, **1**, or **2** points.
Items 5–13: Score **0**, **4**, **5**, **6**, or **7** point

Start	Item	Design	Presentation Method	Time Limit	Completion Time	Constructed Design	Score
6–8	1.	Examinee / Examiner	Model and Picture	30"	Trial 1 / Trial 2	Trial 1 / Trial 2	0 1 2
	2.		Model and Picture	30"	Trial 1 / Trial 2	Trial 1 / Trial 2	0 1 2
9–90	3.		Model and Picture	45"	Trial 1 / Trial 2	Trial 1 / Trial 2	0 1 2
	4.		Model and Picture	45"	Trial 1 / Trial 2	Trial 1 / Trial 2	0 1 2
	5.		Picture	60"			21–60 16–20 11–15 1–10; 0 4 5 6 7
	6.		Picture	60"			21–60 16–20 11–15 1–10; 0 4 5 6 7
	7.		Picture	60"			21–60 16–20 11–15 1–10; 0 4 5 6 7
	8.		Picture	60"			21–60 16–20 11–15 1–10; 0 4 5 6 7
	9.		Picture	120"			71–120 46–70 31–45 1–30; 0 4 5 6 7
	10.		Picture	120"			61–120 46–60 36–45 1–35; 0 4 5 6 7
	11.		Picture	120"			61–120 46–60 36–45 1–35; 0 4 5 6 7
6–8 STOP	12.		Picture	120"			61–120 46–60 36–45 1–35; 0 4 5 6 7
	13.		Picture	120"			101–120 81–100 56–80 1–55; 0 4 5 6 7

Maximum Raw Score
Ages 6–8: 57
Ages 9–90: 71

Block Design Total Raw Score

2 **WASI–II** Record Form

2. Vocabulary

Start
Ages 6–90: Item 4

Reverse
Ages 6–90: Does not obtain a perfect score on *either* Item 4 or Item 5, administer the preceding items in **reverse** order until two consecutive perfect scores are obtained.

Discontinue
After **3** consecutive scores of 0.

Stop
Age 6: After Item 22.
Ages 7–11: After Item 25.
Ages 12–14: After Item 28.

Record & Score
Items 1–3: Score **0** or **1** point.
Items 4–5: Score **0** or **2** points.
Items 6–31: Score **0**, **1**, or **2** points.
See the Manual for sample responses.

Item	Response	Score
1. Fish		0 1
2. Shovel		0 1
3. Shell		0 1
–90 †4. Shirt		0 2
5. Car		0 2
6. Lamp		0 1 2
7. Bird		0 1 2
8. Tongue		0 1 2
9. Pet		0 1 2
10. Lunch		0 1 2
11. Bell		0 1 2
12. Calendar		0 1 2
13. Alligator		0 1 2
14. Dance		0 1 2

†If the examinee provides a 2-point response that requires feedback or gives an incorrect (0 point) response, provide corrective feedback as instructed in the Manual.

continue

2. Vocabulary *(continued)*

Discontinue after **3** consecutive scores of 0.

	Item	Response	Score
	15. Summer		0 1 2
	16. Reveal		0 1 2
	17. Decade		0 1 2
	18. Entertain		0 1 2
	19. Tradition		0 1 2
	20. Enthusiastic		0 1 2
	21. Improvise		0 1 2
	22. Haste		0 1 2
6 STOP	23. Trend		0 1 2
	24. Impulse		0 1 2
	25. Ruminate		0 1 2
7–11 STOP	26. Mollify		0 1 2
	27. Extirpate		0 1 2
	28. Panacea		0 1 2
12–14 STOP			

continu

2. Vocabulary *(continued)*

Discontinue after **3** consecutive scores of 0.

Item	Response	Score
29. Perfunctory		0 1 2
30. Insipid		0 1 2
31. Pavid		0 1 2

Maximum Raw Score
Age 6: 41
Ages 7–11: 47
Ages 12–14: 53
Ages 15–90: 59

Vocabulary Total Raw Score ☐

3. Matrix Reasoning

Start
Ages 6–8: Sample Items A & B, then Item 1
Ages 9–90: Sample Items A & B, then Item 4

Reverse
Ages 9–90: Does not obtain a perfect score on *either* Item 4 or Item 5, administer the preceding items in **reverse** order until two consecutive perfect scores are obtained.

Discontinue
After **3** consecutive scores of 0.

Stop
Ages 6–8: After Item 24.

Record & Score
Score **0** or **1** point.
Correct responses are in color.

	Item	Response					Score	
6–90	SA.	1	**2**	3	4	5		
	SB.	1	2	**3**	4	5		
6–8	1.	1	**2**	3	4	5	0	1
	2.	**1**	2	3	4	5	0	1
	3.	1	2	**3**	4	5	0	1
9–90	4.	**1**	2	3	4	5	0	1
	5.	1	2	3	4	**5**	0	1
	6.	**1**	2	3	4	5	0	1
	7.	1	2	**3**	4	5	0	1
	8.	1	2	**3**	4	5	0	1
	9.	1	2	3	**4**	5	0	1
	10.	1	**2**	3	4	5	0	1
	11.	1	2	**3**	4	5	0	1
	12.	1	2	3	**4**	5	0	1
	13.	**1**	2	3	4	5	0	1
	14.	1	2	3	**4**	5	0	1

	Item	Response					Score	
	15.	1	**2**	3	4	5	0	1
	16.	1	2	3	4	**5**	0	1
	17.	1	2	3	**4**	5	0	1
	18.	1	**2**	3	4	5	0	1
	19.	1	2	3	**4**	5	0	1
	20.	1	**2**	3	4	5	0	1
	21.	1	2	**3**	4	5	0	1
	22.	1	2	**3**	4	5	0	1
	23.	**1**	2	3	4	5	0	1
	24.	1	2	3	**4**	5	0	1
6–8 STOP								
	25.	1	2	3	**4**	5	0	1
	26.	1	**2**	3	4	5	0	1
	27.	1	2	3	4	**5**	0	1
	28.	1	2	3	4	**5**	0	1
	29.	**1**	2	3	4	5	0	1
	30.	1	**2**	3	4	5	0	1

Maximum Raw Score
Ages 6–8: 24
Ages 9–90: 30

Matrix Reasoning Total Raw Score ☐

WASI–II Record Form 5

4. Similarities

Start
Ages 6–8: Item 1
Ages 9–90: Item 4

Reverse
Ages 9–90: Does not obtain a perfect score on *either* Item 4 or Item 5, administer the preceding items in **reverse** order until two consecutive perfect scores are obtained.

Discontinue
After **3** consecutive scores of 0.

Stop
Ages 6–8: After Item 22.

Record & Score
Items 1–3: Score **0** or **1** point. Correct responses are in **color**.
Items 4–5: Score **0** or **2** points.
Items 6–24: Score **0**, **1**, or **2** points. See Manual for sample responses.

	Picture Item	Response					Score		Picture Item	Response					Score		Picture Item	Response					Score	
6–8	†1.	1	2	**3**	4	5	0	1	2.	1	2	3	**4**	5	0	1	3.	1	**2**	3	4	5	0	1

	Verbal Items	Response	Score
9–90	§† 4. Green–Blue		0 2
	§† 5. Square–Triangle		0 2
	6. Cow–Bear		0 1 2
	7. Shirt–Jacket		0 1 2
	8. Pen–Crayon		0 1 2
	9. Hat–Umbrella		0 1 2
	10. Airplane–Bus		0 1 2
	11. Door–Window		0 1 2
	12. Child–Adult		0 1 2

§If the examinee provides a response that suggests he or she does not understand the task, provide the specified prompt in the Manual.
†If the examinee provides a 2-point response that requires feedback or provides an incorrect (0 point) response, provide corrective feedback as instructed in the Manual.

continue

Similarities *(continued)*

Discontinue after **3** consecutive scores of 0.

Verbal Items	Response	Score
13. Shoulder–Ankle		0 1 2
14. Love–Hate		0 1 2
15. Smooth–Rough		0 1 2
16. Hand–Flag		0 1 2
17. Wall–Line		0 1 2
18. Heat–Wind		0 1 2
19. More–Less		0 1 2
20. Shadow–Echo		0 1 2
21. Tradition–Habit		0 1 2
22. Peace–War		0 1 2
STOP 23. Time–Progress		0 1 2
24. Memory–Practice		0 1 2

Maximum Raw Score
Ages 6–8: 41
Ages 9–90: 45

Similarities Total Raw Score ☐