Predicting dual-language literacy attainment in Irish-English bilinguals: language-specific and language-universal contributions

Emily Barnes

Supervisors: Professors Ailbhe Ní Chasaide and Neasa Ní Chiaráin

Thesis submitted for the degree of Doctor of Philosophy

Phonetics and Speech Laboratory

School of Linguistic, Communication and Speech Sciences

Trinity College Dublin

January 2021

Declaration

I declare that this thesis has not been submitted as an exercise for a degree at this or any other university and it is entirely my own work.

I agree to deposit this thesis in the University's open access institutional repository or allow the Library to do so on my behalf, subject to Irish Copyright Legislation and Trinity College Library conditions of use and acknowledgement.

I consent to the examiner retaining a copy of the thesis beyond the examining period, should they so wish.

Signature of author:

Emily Barnes

Acknowledgements

This research would not have been possible without the support and commitment of many people, to whom I am very grateful.

Ba mhaith liom buíochas ó chroí a ghabháil leis na hOllaimh Ailbhe Ní Chasaide agus Neasa Ní Chiaráin as an léargas, tacaíocht, misneach agus cairdeas a thug sibh dom thar na blianta. Tá mé tar éis i bhfad níos mó ná an méid atá sa tráchtas seo a fhoghlaim uaibhse.

Ba mhaith liom buíochas mór a ghabháil leis an Dr. John Harris, leis an Dr. Claire Dunne agus leis an Ollamh Ram Frost as an léargas agus an saineolas a roinn sibh liom - thug sibh súil eile dom.

Ba mhaith liom buíochas a ghabháil le daoine eile i réimse an oideachais agus i réimse na litearthachta a thug comhairle agus deiseanna foghlama dom le linn na céime, go háirithe leis an Ollamh Noel Ó Murchadha.

I would like to thank the Irish Research Council for funding this work and for supporting research of this kind. Chomh maith leis sin, ba mhaith liom buíochas a ghabháil leis An Chomhairle um Oideachas Gaeltachta agus Gaelscolaíochta, a mhaoinigh taighde a bhí ina bhunús don saothar seo.

Tá moladh mór tuilte ag na páistí a ghlac páirt sa taighde seo, a bhí an-chairdiúil agus fáilteach liom – go raibh míle maith agaibh! Chomh maith leis sin, tá mé thar a bheith buíoch de na tuismitheoirí, múinteoirí agus príomhoidí a chuir fáilte romham sna scoileanna a bhí páirteach sa taighde seo.

I am indebted to my friends – from home and from college – for the support, inspiration and perspective they provide. I have also been fortunate to have great friends in the Phonetics and Speech Laboratory who have provided me with much camaraderie and cat-related content (as well as the odd perception test) over the last number of years. I would particularly like to thank Kate and Connor, who read and advised on drafts of this dissertation.

Thank you to my family – my parents Christine and Paul, brother Andrew and husband James – for your love, levity and all of the opportunities you have given me to grow. Gabhaim buíochas mór le mo sheanmháthair Bríghdín Cassidy, a thug grá don Ghaeilge agus don léann dom – thosaigh an obair seo leatsa.

Abstract

This thesis focuses on dual-language literacy attainment and has three main aims. The first is to examine various predictors of early literacy attainment in Irish and English – phonemic awareness, rapid automatised naming and verbal short-term memory – in new and native speakers of Irish. The second aim is to investigate the extent to which these abilities are language-universal, rather than language-specific. The third aim is to examine the nature of one of the predictors - phonemic awareness - in depth.

Phonemic awareness is widely considered to be a language-universal skill in dual-language learners, however this thesis investigates whether there is an additional language-specific component to phonemic awareness. In addition, this thesis explores (i) the extent to which phonemic awareness is a purely phonological ability (ii) the phonemic contrasts which are inaccurately identified by early readers of Irish and English and (iii) whether these errors in phonemic awareness are reflected in the spelling errors made in each language.

To achieve the aforementioned aims, a cross-sectional study was carried out with 345 children in Grade 1 (Junior Infants), Grade 2 (Senior Infants) and Grade 3 (First Class) during the 2018-2019 school year. The majority of these participants (n = 282) attended Gaelscoileanna and a smaller number (n = 63) attended Gaeltacht schools. Participants completed a battery of tasks in both Irish and English. The battery included two phonemic awareness tasks – one tapping a language-universal component and one tapping a language-specific component. It also included rapid automatised naming tasks, verbal-short term memory tasks, literacy tasks as well as a productive vocabulary task in Irish only.

In relation to the predictors of literacy attainment, the findings indicate that the efficacy of the predictors differed in each language. Overall, they predicted more variance in Irish word reading (54%) and spelling (40%) than English word reading (49%) and spelling (36%). The findings also indicate that phonological, cognitive and literacy abilities comprise both language-specific and language-universal components. Spelling errors were found to be largely language-specific and reflect the phonological and orthographic challenges posed by each language. The implications of these findings are that (i) language-specific instruction is necessary in key areas, particularly in relation to the phonemic structure and grapheme-phoneme rules of each language, and (ii) literacy assessment should be carried out in each of a bilingual's languages.

Table of Contents

List of Figures

List of Tables

List of Acronyms

CV	Consonant-vowel
EM	English-medium
FPC	Frequency of parental communication
GS	Gaelscoil
GT	Gaeltacht
HRA	Hierarchical Regression Analysis
HRM	Hierarchical Regression Modelling
IM	Irish-medium
L1	First language
L2	Second language
LPA	Linguistic phonemic awareness
MPA	Metalinguistic phonemic awareness
PA	Phonemic awareness
RAN	Rapid automatised naming
RQ	Research Question
VSTM	Verbal short-term memory
WR	Word reading

CHAPTER 1

INTRODUCTION

This thesis examines early literacy attainment in Irish and English in children in Gaelscoileanna (Irish immersion schools) and schools in An Ghaeltacht (Irish-speaking areas). Three related themes are examined to this end, including (i) which phonological and cognitive abilities predict word reading and spelling in Irish and English (ii) the extent to which these abilities are language-universal, as opposed to language-specific, and (iii) the nature and validity of one of these abilities; bilingual phonemic awareness. In addition to phonemic awareness, rapid automatised naming and verbal short-term memory are investigated as possible predictors of literacy attainment in each language (conceptual and operational definitions for these terms are provided in § 1.4.2).

1.1 Organisation of this thesis

The organisation of the thesis is as follows:

Chapter 1 introduces the motivation for the current thesis, as well as the research questions it investigates and the objectives it aims to achieve.

Chapter 2 provides a frame of reference to the topics discussed in this thesis including (i) the sociolinguistic context of Irish in Ireland (ii) Irish phonology and orthography and (iii) demographic and environmental factors affecting literacy attainment.

Chapter 3 consists of a review of the literature, including an examination of the phonological and cognitive tasks that predict literacy, the constructs they measure, the degree to which they are considered language-universal skills and their efficacy as predictors across languages and in dual language learners.

Chapter 4 describes the development of the task battery used in this study. Novel tasks were designed to maximise the equivalence of the Irish and English versions of each task. The development process involved pre-tests with children in Gaelscoileanna to evaluate the task battery before it was finalised.

Chapter 5 describes the methodology used in this cross-sectional study, including the sampling method, data collection procedures and data analysis methods. It also provides a description of the participants and their language background.

Chapter 6, 7 and 8 present the results pertaining to each of the research questions. Chapter 6 relates to Research Questions 1, 2 and 3; Chapter 7 relates to Research Questions 4 and 5; Chapter 8 pertains to Research Question 6.

Chapter 9 presents a discussion of the results obtained, an outline of the theoretical and practical contributions of this thesis as well as considerations for future research.

1.2 Rationale for this work

This thesis was motivated by a number of inter-related factors which hinder the ability to identify literacy difficulties in Irish-medium education. The first is a gap in research in relation to the predictors of literacy attainment in Irish-English bilinguals, and with regard to the extent to which these predictors are language-universal, rather than language-specific. The second is the lack of screening and diagnostic tests with normative data for those in Irish-medium education. This paucity of provision is both a result of linguistic inequality and a source of further linguistic inequality.

Linguistic inequality arises from the unequal social valuation of languages and exacerbates broader social, economic and cultural equalities which exist in a society (Bonnin, 2013). While education is provided in both English-medium and Irish-medium schools in Ireland, tools and resources essential for the accurate diagnosis of literacy difficulties are only available in English. This is likely to contribute to the lack of early identification of dyslexia in Irish-medium schools (Nic Aindriú et al, 2020) and the potential of misdiagnoses in native Irish speakers (Barnes, 2017).

A considerable amount of research and investment in test development and intervention is necessary to offset the extensive deficiencies in the provision of resources, and in order to provide a more equitable educational landscape in Ireland. This need for such resources is recognised by the Polasaí don Oideachas Gaeltachta [Policy on Gaeltacht Education] 2017-22. One of the goals of the Polasaí don Oideachas Gaeltachta is to improve the provision of language resources and supports, and a specific objective is to develop assessment tools for those in Gaeltacht schools (Department of Education and Skills, 2016). Though this study does not have a sample large enough to provide normative data for students in Gaeltacht schools or Gaelscoileanna, it is hoped that the findings could inform the development of such assessment tools.

This thesis aims to contribute towards future resources in two ways. Firstly, it aims to provide fundamental research in relation to the predictors of literacy attainment in Irish and English for the cohorts under study, elucidating the extent to which the predictors are language-universal, an aspect that has practical implications for the design of future

screening materials. Secondly, it aims to contribute by developing an initial bilingual battery of tasks and evaluating their efficacy in predicting literacy attainment in Irish-English bilinguals. These are essential elements for future Irish bilingual literacy education.

1.3 Theoretical standpoint

This research been undertaken with the view that genetic, cognitive, neurobiological and environmental factors interact and contribute towards both 'typical' and 'atypical' language and literacy development. This is in line with a neuroconstructivist viewpoint (e.g. Oliver et al, 2000), which emphasises that cognitive abilities are developmental processes rather than pre-determined end states and that there are multi-directional interactions between various factors. The social factors that influence language-learning and literacy outcomes are also considered important elements of this viewpoint. A point of particular importance – given the focus of the present study – is that new speakers of a language make conscious decisions in relation to their assimilation to L1 norms based on a number of sociological factors, including their language-learning motivations, self-concept and self-identity (Edwards, 2008; Moyer, 2017).

The contribution of statistical learning mechanisms[1] to language and literacy development is also acknowledged. This is not to endorse the perspective that the learner is passive in the learning process. Indeed, Frost and colleagues (2019) emphasise that (i) people are active participants in statistical learning and (ii) statistical learning occurs against the backdrop of prior knowledge, meaning that first language (L1) regularities can bias second language (L2) learning. Given that there are many regularities (patterns) which a learner may attend to, and that the learner has limited learning resources, they attend to certain preferred regularities (Frost et al, 2019). Within the realm of language, learners appear to attend to regularities with perceived communicative value (Ferguson & Waxman, 2016).

In short, I assume that

I. There are multiple factors (genetic, cognitive, neurobiological, environmental, social) which contribute to language and literacy attainment;
II. Learners attend to and learn regularities in spoken and written language;
III. Learners' attention is limited, meaning that they attend to certain (preferred) regularities which they perceive to have communicative value;

[1] Mechanisms that contribute to the learning of patterned regularities gleaned from sensory input (Frost et al, 2019)

IV. Current learning occurs within the context of prior learning, which means that L1 regularities can bias L2 learning.

1.4 Objectives of this thesis

The objectives of this thesis are:

I. To examine the predictors of early literacy attainment in Irish and English in new and native speakers of Irish.
II. To investigate the extent to which these abilities are language-universal, rather than language-specific.
III. To investigate the nature of bilingual (Irish-English) phonemic awareness in depth.

These three objectives are formulated in terms of specific research questions, which are detailed in § 1.6. As the means of pursuing these objectives, while addressing the local deficit of resources, this study also has additional practical objectives:

IV. To develop a battery of tasks which are maximally equivalent in Irish and English in order to examine literacy attainment and the aforementioned predictors.
V. To provide the theoretical underpinning and empirical data to guide the development of an early literacy training platform for Irish, being developed as part of the ABAIR initiative at the Phonetics and Speech Laboratory, Trinity College Dublin. This platform is also intended in the longer term to provide literacy screening tools and remediation materials, to which the materials of IV above represent a starting point. This is discussed further in § 2.3.3

1.5 Terminology and Definitions

For clarity, distinctions between terms which have similar meanings are outlined in § 1.5.1. Conceptual and operational definitions for the cognitive constructs examined in this thesis are provided in § 1.5.2.

1.5.1 Terminology

Literacy development is used in this thesis when discussing the various factors which affect how readily a person becomes literate. *Literacy attainment* on the other hand, is used in the context of studies which measure word/non-word reading and spelling at a given point in time. The former term captures the nature of literacy development as a complex process, while the latter term refers to performance on a particular literacy task at a given time point.

The terms *dual-language learner* and *bilingual* are used interchangeably in this thesis; this is not an unusual practice, given the overlap between the two concepts (e.g. Barac et al, 2014). The term dual-language learner can be defined simply as a person learning two languages (e.g. Hammer et al, 2014). Bilingualism can be broadly defined as a spectrum of language experiences which involve the use of more than one language; this contrasts with narrower definitions in which bilingualism is treated as a categorical variable (De Luca et al, 2019). As such, all of the participants of the study reported in this thesis are considered bilingual.

There are many ways to categorise types of bilingualism, including by age of acquisition, functional ability or cultural identity (Butler, 2013). In the present thesis, attention is paid to the context of language acquisition; as such, a distinction is made between participants who attend Gaelscoileanna (whose primary language-learning environment is the school) and those who attend Gaeltacht schools (whose primary language-learning environment is often the home and/or community: see § 2.1).[2]

The term *new speaker* is used in this thesis with reference to the participants of this research who do not speak Irish at home, but attend Gaelscoileanna (the new speaker paradigm is further discussed in § 2.1.2). The term *second language* (or its abbreviation: L2) is used as an adjective in a number of established terms relating to cognitive or linguistic constructs (for example, second language phonological acquisition). It is recognised that, within the new speaker paradigm, the term L2 is considered deprecatory when used to describe a speaker (e.g. O'Rourke et al, 2015). It is used in the present study only to describe constructs; this decision was made due to the fact that these terms are well-established. Needless to say, there are no value judgements intended in the present usage.

1.5.2 Conceptual and operational definitions

Only a brief overview of the tasks used to operationalise these concepts is provided here; the process of selecting task types and developing the stimuli for each task is discussed in detail in Chapter 4.

I. **Phonemic awareness (PA)** is the ability to identify and manipulate the phonemes that comprise spoken words (Goswami & Bryant, 1990; Castles & Coltheart, 2004). In this study, it is investigated as two separate components.
    a. The linguistic component (linguistic phonemic awareness: LPA) is operationalised using a Phoneme Matching task in which the participant is

[2] In previous work, O'Toole and colleagues (2019) have referred to those from Irish-dominant homes and those from bilingual homes as *home-generated bilinguals*, and those from English-dominant homes as *school-generated bilinguals,* based on DeHouwer (2011).

required to indicate whether the initial phoneme of two words are matching or mismatching. This component is hypothesised to be language-specific as it assesses knowledge of a language's phonemic structure, a domain which can differ substantially between languages.

b. The metalinguistic component (metalinguistic phonemic awareness: MPA) is operationalised using a Phoneme Deletion task in which the participant is required to delete a phoneme from initial or final position in a word. This component is likely to be largely language-universal in alphabetic languages[3], as it assesses a skill which relies on the ability to perform an operation on a phoneme within a word but does not require language-specific knowledge about a given phoneme.

II. **Rapid automatised naming (RAN)** assesses the degree of automaticity between visual and phonological connections (Norton & Wolf, 2012). In this study it is operationalised using a RAN (objects) task, requiring the participant to name a series of pictures on a page as quickly as possible.

III. **Verbal-short term memory (VSTM)** involves the temporary storage of verbal information in the phonological loop of short-term memory (Baddeley, 2003). In this study it is operationalised using a Forward Word Span task, requiring participants to listen to a list of words and recall them verbally.

IV. **Productive Vocabulary** is measured using a task which requires the participant to name pictures of objects.

V. **Literacy attainment** is measured using a word reading task and a spelling task.

Note that these tasks – with the exception of the word reading task and spelling task - are purely verbal; the participant does not have access to the written form of the word.

1.6 Research Questions

The constructs investigated in the present thesis and the research questions (RQs) that relate to each one are illustrated schematically in Figure 1. The constructs in the left-hand column – phonemic awareness (PA), rapid automatised naming (RAN), verbal short-term memory (VSTM) and Irish productive vocabulary – are possible predictors of literacy attainment while those in the right-hand column are measures of literacy attainment. All of the

[3] Note that differing results have been obtained in languages which do not represent the phonological structure at the level of the phoneme (e.g. Saiegh-Haddad & Geva, 2008). Due to the effect that orthography has on performance on phonemic awareness tasks (discussed further in § 3.1.1), this is not unexpected. The discusssion in this thesis is constrained mainly to languages which use an alphabet.

constructs are investigated as part of RQ6, and a subset of constructs are investigated in the remaining RQs.

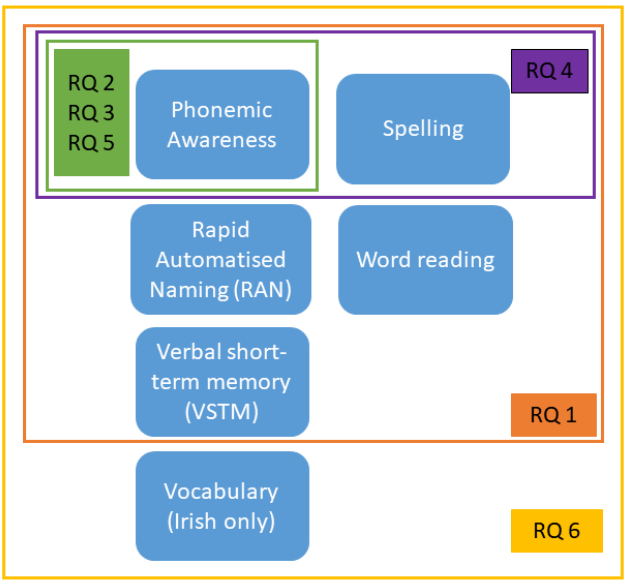

Figure 1 Schematic representation of the constructs investigated in the present thesis and the research questions relating to each one

RQ1 Do scores for Irish-English bilinguals support the assertion that phonological and cognitive abilities (phonemic awareness, rapid automatised naming, verbal short-term memory) and literacy skills are language-universal?

This question examines the extent to which we can consider PA, RAN, VSTM and literacy skills to be language-universal within Irish dual-language learning contexts. In order to investigate this, participants will be administered equivalent tasks in Irish and English. The data will be analysed (separately for Gaeltacht and Gaelscoil participants) to examine whether a significant difference exists between scores on the Irish and English version of each task. If no significant difference is found, it would suggest that this group of dual-language learners have a common underlying proficiency across languages, as suggested by Cummins (1981).

One previous study examined (Irish-English) dual-language literacy attainment on a relatively large scale (Parsons and Lyddy, 2016). The results of this study suggest that children in Gaelscoileanna performed as well as their English-medium peers in English word and nonword reading by Grade 4, and outperformed them in Irish reading. Another study by Ní Chiaruain (2009) examined Irish and English literacy skills in three children with dyslexia in a Gaelscoil, and found that though there was no significant difference

between Irish and English reading scores, there was evidence that children were using different strategies to read English and Irish words. This suggests a common underlying proficiency, but also indicates that there is a language-specific component to dual-language literacy attainment. A further relevant study from the Irish context was conducted by Murphy and Travers (2012), who tested early literacy skills in both Irish and English in a group of Gaelscoil pupils and found that overall, the group had higher scores in Irish on certain subtests and in English on others; this indicates a language-specific element to early literacy subskills and emphasising the importance of bilingual testing in order to gain an accurate picture of a child's abilities.

Though PA is typically considered a language-universal skill (e.g. Chung et al, 2019; *cf* Saiegh-Haddad, 2019), there has been no investigation into the extent to which this is true of Irish-English bilinguals. Similarly, there is no data in relation to the nature of RAN in Irish-English bilinguals, though findings in other language contexts indicate that bilinguals are more efficient at RAN tasks in their dominant language than in their non-dominant language (Gollan et al, 2008; Pae et al, 2009). In contrast to the language-specific nature of RAN, VSTM has been found to be a common cognitive process in Irish-English bilinguals (McVeigh et al, 2019).

The findings pertaining to this question – particularly in relation to PA and literacy attainment - have practical implications for instruction, given the focus on the transfer of phonological and literacy skills in the Primary Language Curriculum in Ireland (National Council for Curriculum and Assessment, 2015). In addition, the findings should shed light on the appropriateness of providing English-language literacy screening and diagnostic assessments to dual-language learners, given that PA, RAN, VSTM and literacy tasks typically form part of these assessments.

RQ2 To what extent can metalinguistic phonemic awareness and linguistic phonemic awareness be considered the same construct (i) within languages and (ii) across languages?

This question investigates whether there exists both a metalinguistic component to phonemic awareness (metalinguistic phonemic awareness: MPA) and a more fundamentally linguistic component (linguistic phonemic awareness: LPA), as proposed by Saiegh-Haddad (2019). To examine this, Phoneme Matching scores (measuring LPA) and Phoneme Deletion scores (measuring MPA) will be entered into a correlationary analyses. This method of analysis is typically used to examine construct validity and the extent to which two tasks measure the same construct (Cronbach & Meehl, 1955; though see Delis et al, 2003 for an alternative perspective on this matter).

This research question contains two related parts.

I. The first concerns the degree of correlation between Phoneme Matching and Phoneme Deletion scores within each language. This is an indication of the extent to which LPA and MPA are components of a single construct (i.e. a unitary construct of phonemic awareness), as opposed to two separable constructs, within a language.

II. The second relates to the extent to which Phoneme Matching scores are correlated in Irish and English, and the extent to which Phoneme Deletion scores are correlated in Irish and English. A higher degree of correlation would indicate a higher degree of language-universality within each construct.

The findings pertaining to this research question have implications for pedagogy. If MPA and LPA are separable constructs within a language, it would stand to reason that they should each be independently trained and independently assessed. If LPA is found to be a language-specific construct, then the curriculum should emphasise language-specific training rather than the transfer of skills.

RQ3 Which phonemic contrasts are typically identified inaccurately in Irish-English bilinguals?

This question examines which phonemic contrasts pose a difficulty for early readers of Irish and English. Previous research indicates that the degree of similarity between phonemes affects the accurate identification of L1 phonemes (Treiman et al, 1998). An extra level of complexity exists with regard to the accurate identification of L2 phonemes; dual-language learners may need to establish a new phonetic category in order to reliably distinguish between L2 phonemes. In order to do so, they must identify a phonetic difference between an L1 and L2 phoneme (Flege, 1995). Not all children in Gaelscoileanna have exposure to Irish native speaker speech, which limits the opportunity to establish new phonetic categories.

This question will be examined using the average (group-level) accuracy of individual items on a Phoneme Matching task, which requires participants to indicate whether the initial phoneme in two words is the same or different. Items with average (group-level) accuracy below the level of chance (50%) will be considered typical phonemic awareness errors. The findings pertaining to this research question will be used to inform the content of the aforementioned early literacy training platform in Irish, currently under development

in the Phonetics and Speech Laboratory, Trinity College Dublin (discussed further in § 2.3.4).

RQ4 Are phonemic awareness errors reflected in the spelling errors made in Irish and English?

Spelling requires the accurate encoding of phonological information into orthographic representations. Given the phonological requirements of the task, it is perhaps unsurprising that PA has been found to contribute more to spelling than to reading (Furnes & Samuellson, 2011). This is an important consideration in a dual-language environment given that inaccuracies that occur in L2 phonological perception can manifest in spelling errors (for an overview see Figueredo, 2006). However, there is no previous research which examines spelling errors in Irish and English and to what extent they are related to poor phonemic awareness. To answer this question, the spelling errors made in Irish and English will be categorised using the error analysis framework outlined in § 7.3.1. The findings pertaining to this question provide an indication of the utility and value of examining and training LPA in each language.

RQ5a Is there evidence of orthographic effects or the use of orthographic strategies on responses to linguistic and/or metalinguistic phonemic awareness tasks?

RQ5b If so, is there a relationship between the use of orthographic strategies and literacy attainment?

Previous research has found evidence of orthographic influences on responses to tasks which measure LPA (Castles et al, 2011) and MPA (Castles et al, 2003; Stuart, 1990). This study intends to examine whether there is evidence of orthographic effects or the use of orthographic strategies on Phoneme Matching and Phoneme Deletion tasks. As this is not a novel area of study, results are intended to (i) extend the findings of previous studies to the dual-language context and (ii) contribute to the discussion in relation to the construct validity of PA. It has been suggested that PA is a measure of the extent to which phonological representations have been alphabetised, rather than the quality of phonological representations themselves[4] (Castles & Coltheart, 2004). In other words, good readers have access to orthographic representations and use them as a visual aid to complete

[4] This is of significant theoretical interest to the study of dyslexia. The most prominent theory of dyslexia is the phonological deficit hypothesis, which posits that people with dyslexia have a deficit in phonological skills (Liberman, 1991; see Snowling, 1995 for a review). This theory was developed to account for poorer performance by those with dyslexia on PA and RAN tasks. However, an alternative theory – that dyslexia stems from a specific deficit in phonological-orthographic binding – has been proposed by Blomert (2011). This matter is discussed further in § 3.1.4.

PA tasks. The relationship between the use of orthographic strategies on PA tasks and bilingual literacy attainment will offer insight into what abilities the PA tasks are measuring in Irish-English bilinguals. This is an essential step in establishing the construct validity of these tasks.

RQ6a How well do scores on the predictor tasks predict word reading and spelling attainment in GS and GT groups in Irish and English?

RQ6b What are the strongest predictors of word reading and spelling attainment in Irish and English in GT and GS groups?

This research question examines how well scores on the predictor tasks (Phoneme Matching, Phoneme Deletion, RAN, Forward Word Span and Productive Vocabulary) predict literacy attainment in Irish and English. Previous studies indicate that the pattern of constructs that predict reading word accuracy and fluency differ in each of a bilingual's languages (Jared et al, 2011; Swanson et al, 2008; Veii & Everatt, 2005; Lindsey et al, 2003; Gottardo & LaFrance, 2005) and that the amount of shared variance between L1 and L2 literacy attainment scores differs depending on the degree of relatedness between the two scripts (Pasquarella et al, 2015).

The sociolinguistic context of Ireland provides an ideal context to add to the research base in this regard due to the supportive dual-language educational environment. There is an additional practical goal related to the investigation of RQ6; it is hoped that this analysis could contribute towards the development of an evidence-based literacy screener in Irish. The findings of RQ6 will indicate which predictor tasks should be included on such a literacy screener and how effective each could be expected to be.

1.7 Chapter summary

This chapter introduced the present thesis and its aims, which include the examination of (i) the predictors of word reading and spelling in Irish and English (ii) the extent to which these constructs are language-universal and (iii) the nature and validity of one of the constructs; bilingual phonemic awareness. These aims give rise to six research questions which are explored as part of a cross-sectional study reported in this thesis. The next chapter provides background information in relation to the Irish sociolinguistic and education context.

CHAPTER 2

THE IRISH CONTEXT: SOCIOLINGUISTIC, LINGUISTIC AND EDUCATIONAL

This chapter provides an examination of sociolinguistic, linguistic and educational factors pertinent to the Irish context, as well as a discussion of the demographic variables which affect literacy attainment. The participants of the study reported in this thesis include both native speakers and new speakers of Irish; the sociolinguistic context of the Gaeltacht schools and Gaelscoileanna from which they were recruited is provided in § 2.1 . Given the considerable influence of linguistic structures on literacy acquisition, some of the main features of Irish phonology and orthography are outlined in § 2.2. In addition to the linguistic structures of each language, there are a number of demographic and environmental variables which may affect literacy development. The contribution of gender, socioeconomic status, literacy instruction methods and exposure to a second language (L2) were considered at all stages of study design and implementation, and are discussed in § 2.3.

2.1 Sociolinguistic context

An overview of the sociolinguistic context of participants in Gaeltacht schools and Gaelscoileanna is outlined in this section. Substantial variation exists between families and individuals within a given context; the home language background of participants in the present study is described in detail in Chapter 5.

2.1.1 Gaeltacht areas

The Gaeltacht Area Orders (1956 – 1982) specified Gaeltacht areas as those which, in the government's view, were substantially Irish speaking (as well as localities neighbouring such areas). These areas were specified as part of An Ghaeltacht with the aim of maintaining and extending the use of Irish as a community language, and include districts in Cork, Donegal, Galway, Kerry, Mayo, Meath and Waterford. Subsequently, the introduction of the Gaeltacht Act (2012) provided for these Gaeltacht areas or districts thereof to be designated as a Language Planning Areas.

Individual Language Planning Areas have more local control of language planning goals, as they can develop area-specific language plans to promote increased use of Irish in all areas of community life. Much variation exists between the Language Planning Areas in terms of the extent to which Irish is spoken in the community (Central Statistics Office, 2016), as well as in other respects, including age profile, population growth, unemployment

rates, educational attainment and number of daily speakers (All-Island Research Observatory, 2018).

As the present study recruited participants from areas within the Galway Gaeltacht, this will be described in more detail here. Of the seven Gaeltacht areas, the Galway Gaeltacht has the largest number of speakers who use Irish daily outside the education system (Central Statistics Office, 2016). The proportion of residents who speak Irish daily differs greatly between various Language Planning Areas, from 3% in An tEachréidh (North-east of Galway city) to 72% in Ceantar na nOileán in the west of County Galway (Central Statistics Office, 2016). For this study, participants were recruited from Category A districts, in which more than 67% of the community speak Irish daily (Ó Giollagáin et al, 2007).

Both of the Gaeltacht schools that participated in the current study have Gaeltacht status and receive additional resources as a result of the Polasaí don Oideachas Gaeltachta 2017-22 (Policy on Gaeltacht Education: Department of Education and Skills, 2016). Schools with Gaeltacht status do not teach any English during the first two years of schooling, and as such initial experiences of literacy are all through Irish. The aforementioned policy provides for additional teaching resources in Gaeltacht schools, and also provides additional funding to An Comhairle Um Oideachas Gaeltachta agus Gaelscolaíochta (COGG) for the development of teaching and learning resources (Department of Education and Skills, 2016). An initial report on its implementation indicated that the additional resources are being used to provide language and literacy support through collaborative work between support teachers and the class teacher (Department of Education and Skills, 2018). It was also reported that the use of real books in Irish is promoted in such schools, and that reading books, text books and phonics schemes in Irish were being used in the implementation of support in such schools (Department of Education and Skills, 2018). Though the effect of Gaeltacht status and the accompanying additional resources is likely to vary from school to school, it is probable that this resulted in greater access to literacy resources and support in these schools.

One of the participating Gaeltacht schools is part of a national programme entitled Delivering Equality of Opportunity in Schools (DEIS: Department of Education and Skills, 2005). Schools with DEIS status have access to additional resources and supports, including additional staffing and funding as well as access to literacy and numeracy programmes (Department of Education and Skills, 2011). Overall, students in schools with DEIS status have lower reading scores than their peers in non-DEIS schools at post-primary level (Gilleece et al, 2020). However, a previous analysis of urban-rural differences

indicated that pupils in rural DEIS schools had higher English reading scores than their peers in urban DEIS schools, and that their scores did not differ significantly from the national norms (Weir et al, 2009). Similarly, Harris and colleagues (2006) found that the Irish reading comprehension scores of low-SES students in Gaeltacht schools did not differ significantly from their high-SES peers. The implications of this for the current study are that (i) the participating school with DEIS status is likely to have had additional resources and funding to implement literacy programmes, and (ii) there is no evidence that the reading scores of participating pupils from this school should differ significantly from those of their peers in non-DEIS schools.

The English language is pervasive, even within Gaeltacht areas, and this results in a high degree of language change in Irish. Though, as a group, Gaeltacht pupils are more fluent in Irish, their phonetic and grammatical accuracy[5] have been claimed to be stronger in English (Péterváry et al, 2014). Recent studies report a lack of grammatical development in young Gaeltacht children, and that inconsistent use of the grammatical system by parents is mirrored in children (Muckley, 2015; Antonijevic et al, 2019). In spite of this, overall, young people are quite highly proficient in Irish and also positively disposed to Irish in Gaeltacht areas (Ó Giollagáin et al, 2007).

2.1.2 Areas outside of the Gaeltacht

Outside of the Gaeltacht, children may attend an English-medium school or a Gaelscoil. In Gaelscoileanna, Irish is the official medium of instruction for all subjects except English. In the school year 2018/19, there were a total of 145 Gaelscoileanna with 37, 838 enrolled students (Gaeloideachas, 2020; note that this does not include Gaeltacht schools). There has been a steady rise in the proportion of total schools in Ireland which are Irish-medium (both Gaelscoileanna and Gaeltacht) schools, from 6.4% of schools in 2000 to 8.1% in 2018 (Gaeloideachas, 2020). An in-depth description of the historical, cultural and linguistic context of Gaelscoileanna is provided by Ó Duibhir (2018).

One factor which should frame the discussion in relation to educational attainment in Irish-medium education is that of parental involvement. Previous research in the Irish-medium education context indicates that parents from a wide variety of socioeconomic backgrounds chose immersion education for their child due to the educational benefits associated with it (Kavanagh, 2013). Kavanagh considers that selecting immersion education for children may suggest "an interest in, and commitment to, education which transcends formal

[5] This was based on an analysis of grammatical accuracy (case/number of nouns, verbs, prepositions) and phonetic productive accuracy (involving /r/ only) elicited during an interview in which children (n = 50) were asked to describe the actions in a picture book, provide a narrative of a story based on images, answer specific questions and complete tasks based on the book.

educational levels and may be more important in terms of predicting whether a parent will be involved" (pp.248). This sentiment is also supported by Dunne and Hickey (2017), who state that the conscious decision made by parents to send enrol their child in a Gaelscoil may lead to – or be associated with - a greater level of investment in their child's education. An analysis of 75 previous studies confirms that parental involvement is positively associated with academic achievement, with one of the most potent underlying predictive factors being parents' aspirations for their child's academic achievement (Boonk et al, 2018). Indeed, parental involvement has been found to mediate the relationship between socioeconomic status and reading achievement (Guo et al 2018). It may be the case that the commitment to education – as suggested by Kavanagh (2013) – demonstrated by parents who enrol their children in Irish-medium education, mediates the relationship between socioeconomic status and academic achievement.

The majority of children who attend Gaelscoileanna speak English as a first language and learn Irish at school, though some speak Irish or another language at home (this is in line with the language background of participants of the present study, outlined in § 5.5). There is often limited exposure to native speaker Irish in Gaelscoileanna, which has led to the emergence of features which do not adhere to the norms of traditional varieties of Irish (Ó hIfearnáin & Ó Murchadha, 2011). In an analysis of spoken corpora, Ó Duibhir (2009) found that divergences in relation to forms between new speakers in Gaelscoileanna and native speakers of Irish typically pertain to features which do not exist in English (e.g. the distinction between the copula 'is' and the substantive verb 'bí') or which are distinct in English (mapping English syntax to Irish). Still, the vast majority of pupils in Gaelscoileanna attain mastery of the spoken language (as assessed by measures of vocabulary and morphological and syntactic accuracy on an Irish speaking test; Harris et al, 2006).

In relation to phonology, the extent to which the phonological contrast of palatalised and velarised consonants of Irish are maintained in new speakers is an emerging area of empirical research. A recent study by Snesareva (2017) examined the Irish of new speakers of Irish from Dublin; her results indicate that the presence of palatalisation is dependent on the type of consonant (e.g. labial, nasal) and its position (initial, medial, final). Further research in this area is desirable; the extent to which the contrast is maintained is something that is likely to vary considerably among cohorts of new speakers.

The new speaker paradigm - recently introduced in the context of Celtic minority languages – moves away from a deficit model of language competence (e.g. L2, non-native speaker) towards one which legitimises new language varieties and sees the potential new speakers

have to contribute to language vitality (e.g. O Rourke & Walsh, 2015; Ó Murchadha et al, 2018). One of the aims of the present study is to examine new speakers' perception of phonemic contrasts which exist in native speaker varieties of Irish, but which may not be robustly maintained in their own variety.

Though this may seem at odds with the new speaker paradigm, it is not necessarily so. The value of new speakers and their contribution to the vitality of the language is acknowledged here. It is also recognised that attending to fundamental phonological features of Irish is important for phonological accuracy, syntactic-semantic accuracy (differentiation of lexical items, distinguishing between singular and plural nouns, for example), as well as for understanding the phoneme-grapheme rules within the written language.

2.2 Linguistic context

Given that the phonological and orthographical features of a language have a substantial bearing on literacy development in a given language, an overview of some of the main features relevant to the present thesis are provided in this section.

2.2.1 Irish Phonology

There are 3 main dialects of Irish (Ulster, Connaught and Munster), with a number of sub-dialects. Despite a long tradition of literacy, the effects of colonisation and the disenfranchisement of the language meant that a single spoken standard did not emerge. Each of the native dialects are deemed to be a spoken standard, and there is a written standard which has been constructed by drawing on features of the three dialect groups.

One of the most striking features of Irish phonology is the series of velarised-palatalised consonant contrasts (Ní Chasaide, 1999). Velarisation is a secondary articulation of the consonant which entails a positioning of the body of the tongue towards the back of the oral cavity, imparting the resonance of a back vowel. As the term implies, the tongue is raised towards the velum, or indeed may be even more retracted. Palatalisation is a very different secondary articulation, where the consonant is articulated with a fronting of the body of the tongue towards the hard palate, imparting a front vowel resonance. Figure 2 presents the consonant chart of Irish (adapted from Ní Chasaide 1999), as well as that of superaregional Irish-English, included for comparative purposes.

Consonant chart: Irish

		Labial		Dental		Alveolar	Alveolo-palatal		Palatal		Velar		Glo-ttal
Plosive	C^{γ}	p^{γ}	b^{γ}	$\underset{\frown}{t}^{\gamma}$	$\underset{\frown}{d}^{\gamma}$						k^{γ}	g $^{\gamma}$	
	C^{j}	p^{j}	b^{j}				$\underset{\frown}{t}^{j}$	$\underset{\frown}{d}^{j}$	c^{j}	$ɟ^{j}$			
Fricative/ Approximant	C^{γ}	f^{γ}	w^{γ}			s^{γ}					x^{γ}	$ɣ^{\gamma}$	h
	C^{j}	f^{j}	v^{j}				$ʃ^{j}$		$ç^{j}$	j^{j}			
Nasal	C^{γ}		m^{γ}		$\underset{\frown}{n}^{\gamma}$	n						$ŋ^{\gamma}$	
	C^{j}		m^{j}					$\underset{\frown}{n}^{j}$		$ɲ^{j}$			
Tap	C^{γ}					$ɾ^{\gamma}$							
	C^{j}					$ɾ^{j}$							
Lateral approximant	C^{γ}				$\underset{\frown}{l}^{\gamma}$	l							
	C^{j}						$ʎ^{j}$						

Consonant chart: English

	Labial		Dental		Alveolar		Alveolo-palatal		Palatal		Velar		Glo-ttal
Plosive	p	b	$\underset{\frown}{t}$	$\underset{\frown}{d}$	t	d					k	g	
Fricative	f ʍ	v			s	z	ʃ	ʒ					h
Approximant		w				ɹ		j					
Affricate							tʃ	dʒ					
Nasal		m				n						ŋ	
Lateral approximant						l							

Figure 2 Consonant charts for Irish and (supraregional) Irish-English. Note: C^{j} = palatatlised consonant; C^{γ} = velarised consonant. Note also that here and throughout this thesis, these transcriptions are 'overspecified', in that diacritics for both palatalisation and velarisation are provided – even where differences in the primary articulations (such as palatal vs velar) could appear to make this redundant. In each cell, note that symbols on the left are voiceless, while those on the right are voiced.

This phonological contrast of palatalised and velarised consonants can entail further differences in the primary place of articulation – as between the palatal vs. velar stops /c^{j}-/k^{γ}/ and the alveolo-palatal vs. alveolar fricatives /$ʃ^{j}$/-/s^{γ}/. For clarity here and ease of reference in this work, the chart in Figure 2 is overspecified in that *both* velarisation *and* palatalisation are indicated, as well as information on the primary place articulation. It should be noted that there are some differences in the phonetic realisation of the consonants across the different dialects, but that the system of contrasts is essentially much the same. For more discussion of this phonological distinction and its phonetic realisations, see Ní Chasaide, 1979, 1999; Ní Chiosáin & Padgett, 2012; Bennett et al, 2018; Ní Chasaide & Fitzpatrick, 1995; Cooper, 1994).

This fundamental feature of the consonantal system of Irish makes it very different to that of English, entailing essentially a doubling in the inventory size – as can be seen by comparing the consonant chart for Irish and Irish English, both presented in Figure 2. Note also that the consonantal distinction of palatalised vs. velarised segments in Irish carries a high functional load: in addition to differentiating between lexical items, the velarised-palatalised contrast is involved in marking the case and number of nouns (Ní Chasaide, 1999; Ní Chiosáin & Padgett, 2012).[6]

The vowel system of Irish is less unusual, featuring a contrast of long and short vowels, much as in English. Although there are again some cross-dialect differences, particularly in the realisation of certain phonemes, the system described in Ó Murchú (1998) for the Conamara dialect under discussion includes the five long vowels /i: e: a: o: u:/, five short vowels / ɪ, ɛ, a, ʌ, ʊ/, as well as the diphthongs /aɪ, aʊ, ia and ua/.

Although the basic system of vocalic contrasts for Irish and Irish-English are rather similar, it should be noted that the consonantal contrast of palatalised/velarised segments has a knock-on effect on the realisation of the vowels, as they can exert a strong influence on a neighbouring vowel. In the case of the long vowels, diphthongal on- or off-glides may arise, depending on whether the consonant and vowel qualities are "matched" or "mismatched". For example, when a front vowel follows a palatalised consonant ("matching" in that both having front articulation and resonance characteristics) the vowel is realised as a pure front vowel. If, on the other hand, a front vowel follows a velarised consonant (i.e., they "mismatch" in terms of articulation and resonance), a strong diphthongal glide is audible, reflecting the shifting tongue position. (for more on this, see Ní Chasaide, 1979, 1999, Quinn, 2020). In the case of the short vowels, the quality can vary considerably depending on the adjacent consonant (see Ní Chasaide, 1999).

Though there are other interesting features of Irish phonology such as the set of initial mutations, the description here is limited to those features which are the focus of the present study, including the consonantal system – radically different from the English system of consonant contrasts - and the long-short vowel contrasts, which are also found in the English vowel system.

2.2.2 Irish orthography

In Irish orthography, the velarised-palatalised consonant contrasts is not directly indicated by the consonant letters, but rather by the neighbouring vowel letter. Thus, both members

[6] Marking the case and number of nouns often involves the replacement of a final velarised consonant with a palatalised one (or vice versa in a smaller number of words).

of a contrast, such as /bʲ/ and /bˠ/ are written with <b> and the neighbouring vowel letter distinguishes between them. Palatalised consonants are neighboured by one of what are termed "slender" vowel letters <e> and <i> (letters which correspond to front vowels). This makes sense: as described above, palatalisation is a secondary articulation of the consonant which entails a positioning of the body of the tongue towards the front of the oral cavity, imparting the resonance of a front vowel. Velarised consonants are indicated by a neighbouring letter from the what are termed "broad" vowel letter group <a>, <o> and <u>: as these letters correspond to back vowels, they "match" the resonance characteristics of the velarised consonant,

Vowel letters thus serve two different functions in Irish orthography. The first is to represent the vowel target phoneme of the syllable nucleus (e.g., the phoneme /i:/, which occurs in the words /bʲi:/ and /bˠi:/, represented in both cases with the letter <í> (the acute accent is explained below). The second function is to mark of the quality of an adjacent consonant. Where the consonant quality and that of the vowel are "mismatched", as for example in the word /bˠi:/ '*yellow*' (a front vowel follows a velarised consonant with back vowel resonance), the spelling requires insertion of one of the "broad" vowels. In this case the letter <u> serves as a pointer to the consonant quality, yielding the spelling <buí>. In the case of the word /bʲi:/ <bí> '*be*', the spelling indicates that consonant and vowel qualities are "matched". This principle is illustrated in Table 1 below.

Table 1
The representation of velarised and palatalised consonants in the Irish orthography

	Initial palatalised consonant	**Orthographic transcription**	**Initial velarised consonant**	**Orthographic transcription**
Front vowel	bʲi:	bí	bˠi:	buí
Back vowel	bʲo:	beo	bˠo:	bó

Long-short vowel contrasts are typically distinguished from one another in the orthography using an acute accent, as demonstrated in Table 2 (Note that the there are multiple ways to spell a given short or long vowel; the simplest corresponding grapheme is provided in these examples).

Table 2
The representation of long and short vowels in the Irish orthography

Short vowels				Long vowels			
Pho-neme	**Letter**	**Example** (ortho-graphy)	**Example** (phonetic transcription)	**Phoneme**	**Letter**	**Example** (orthography)	**Example** (phonetic transcription)
/a/	a	<asal>	/asˠəlˠ/	/aː/	á	<áit>	/aːtʲ/
/ɛ/	e	<eitleán>	/ɛtʲəlʲɑːnˠ/	/eː/	é	<éasca>	/eːsˠkˠə/
/ɪ/	i	<ispín>	/ɪʃpʲiːnʲ/	/iː/	í	<íseal>	/iːʃəlˠ/
/ʌ/	o	<ocras>	/ʌkˠɾˠəsˠ/	/oː/	ó	<óg>	/oːgˠ/
/ʊ/	u	<ubh>	/ʊvˠ/	/uː/	ú	<úr>	/uːɾˠ/

It is perhaps evident that, while there is much consistency in the way in which velarised-palatalised consonant contrasts are represented in the orthography, it is nonetheless quite opaque. The long-short vowels, on the other hand are typically represented transparently by a single letter in the orthography. There is a complicating factor, however; readers must be able to distinguish between vowels letters which denote the vowel phoneme, as opposed to those marking consonant quality.

Orthographic depth. Orthographic depth is a descriptive measure of the extent to which the orthography of a language represents its phonemic structure (Katz & Frost, 1992). It is typically thought of as a continuum, running from transparent orthographies such as Finnish and Spanish to opaque orthographies such as English (Ziegler et al, 2010). Though often presented as a global measure, it has been observed that orthographic depth consists of two dissociable factors: feedforward inconsistency (the number of ways to pronounce a grapheme) and feedback inconsistency (the number ways to spell a phoneme; Ziegler et al, 1997). The orthographic depth of a language affects the length of time it takes to become a proficient reader (Seymour et al, 2003; Aro & Wimmer, 2003; Caravolas et al, 2013).

Irish orthography has a complex, though relatively consistent, set of grapheme-phoneme rules (Stenson & Hickey, 2016). While it is considered a regular orthography, there are many context-dependent rules, multi-letter graphemes and morphophonological changes (Stenson & Hickey, 2016; Barnes, 2017). This puts Irish at a similar level to French and Danish in terms of orthographic depth, which are described by Seymour and colleagues (2003, pp.146) as containing "orthographic inconsistencies and complexities, including multiletter graphemes, context dependent rules, irregularities and morphological effects". The Irish orthography can also be conceptualised in terms of feedforward (grapheme-

phoneme) and feedback (phoneme-grapheme) consistency. Irish parallels French on these measures, being relatively low in feedback consistency (there are multiple ways to spell a given phoneme) and high in feedforward consistency (there are few ways to pronounce a given grapheme).

2.3 Demographic and environmental factors which influence literacy attainment

There are a number of demographic and environmental factors which are controlled for in this study and/or relevant in the interpretation of results. These include socioeconomic status, gender, literacy instruction methods and L2 language exposure.

2.3.1 Socioeconomic status

Socioeconomic status (SES) can be defined from either an economic (class) position or a social (prestige) position (Bradley & Corwyn, 2002), though there appears to be agreement that differing SES entails differing levels of access to resources (Duncan & Magnuson, 2012). There is reliable evidence of SES-related differences on language measures, including vocabulary. These differences have been found between lower SES children and mid or high SES monolingual children (Duncan & Seymour, 2000; Noble et al, 2007). The same pattern has been found in Irish-English bilinguals (Stephens, 2013) Welsh-English bilinguals (Gathercole et al, 2016) and Hebrew-Russian bilinguals (Meir & Armon-Lotem, 2017). Previous studies have found that there are no significant interactions between SES and bilingualism, indicating that SES affects monolingual and bilingual children to the same extent (Calvo & Bialystok, 2014; Meir & Armon-Lotem, 2017).

Though the moderating effect of SES has not been investigated in relation to Irish early literacy attainment (e.g. word reading accuracy), the effect of SES on Irish reading comprehension was examined by Harris and colleagues (2006). This study found that lower SES pupils[7] in English-medium schools and Gaelscoileanna had significantly lower Irish reading comprehension scores than their higher SES peers. However, though there was a difference in the Irish reading comprehension scores of lower SES and higher SES students in the Gaeltacht schools, this difference did not reach statistical significance. As home and school factors partially mediate the association between SES and language abilities (Noble et al, 2007)[8], it may be the case that home and school environments are more homogenous in the Gaeltacht group than in the other groups.

[7] using possession of a medical card and parents' educational attainment as a proxy for SES

[8] This study (Noble et al, 20007) teased apart home and school environment factors (amount of time spend in pre-school prior to elementary education, quality of early education, frequency of pro-academic activities such as reading at home, frequency with which the parents read books/newspapers and the frequency of physical punishment) from basic SES factors (parents' education, occupation and income). It was found that SES accounted for 21% of the variance in language attainment. Further analysis found that home and school

Some challenges have been highlighted in relation to lower-SES pupils in the context of Irish-medium DEIS schools (Ní Chlochasaigh et al, 2018). One of these issues pertains to lower levels of attainment of (academic) English as a first language; it is noted that this is a lack of familiarity with the academic English which is valued in formal education (which could be used to support development of equivalent language in Irish), as opposed to an overall deficit in language skill. Despite this, some teachers were aware that supporting the development of such language skills in Irish was likely to have a positive effect on their language skills in English. Additional issues identified in this study included the lack of appropriate assessment resources, the lack of language support for Irish and the need for additional teacher education in relation to immersion education; these issues are also pertinent to non-DEIS Irish-medium education (Nic Aindriú et al, 2020; 2021).

The SES of the catchment areas of individual schools in the present study was established using the HP Pobal deprivation index[9] , which is used as a proxy for SES. The participating schools cover a broad range of SES levels which is representative of the variance which occurs in Irish-speaking populations. This is further discussed in Chapter 5.

2.3.2 Gender

Gender-related differences in literacy attainment appear to vary depending on the type of literacy skill examined. With regard to unconstrained literacy skills, differences favouring females were identified in a study of Irish reading comprehension in sixth grade in English-medium, Irish-medium and Gaeltacht schools (Harris et al, 2006). This is a typical finding; there is convergent evidence that a gender gap in non-constrained literacy skills exists in the majority of countries (Eivers et al, 2017). There are a small number of countries which do not have a significant gender gap[10] (Eivers et al, 2017), indicating that environmental, cultural and educational factors mediate this difference. Factors that may motivate this difference are discussed in a review by Logan & Johnson (2010) but are beyond the scope of this brief review.

Research by Dunne and Hickey (2017) also indicated that there were gender-related differences in relation to enjoyment of reading as well as confidence in reading ability. At the beginning of an extensive reading intervention, girls in Third Class (the fifth year of schooling) expressed more positive attitudes to reading than boys; however, by the end of the intervention the gap between girls and boys had been eliminated. A different pattern

environment accounted for 16.4% of the variance in language, while basic SES factors accounted for a further 5.7%.

[9] https://maps.pobal.ie/WebApps/DeprivationIndices/index.html

[10] Portugal and Macao (a special administrative region of China in which both Chinese and Portuguese is spoken)

was seen in relation to children in Fifth Class (the seventh year of schooling): both boys and girls showed positive attitudes at the beginning of the intervention, and by then end of the intervention girls expressed more positive attitudes than boys.

Findings in relation to constrained literacy skills are much more varied. For example, one study found no significant gender-related differences in word reading fluency in the initial six years of schooling (McIntosh et al, 2013), another identified significant differences favouring females only in certain grades (Below et al, 2010) while a further study obtained differing findings depending on the instructional methods used (Johnston et al, 2010)[11]. Together, these findings suggest that there is not a reliable gender difference in foundational literacy skills, at least in English-speaking children, and also that the method of reading instruction may play a role in differentiating between male and female readers.

2.3.3 Literacy instruction methods and practices

The place of literacy skills in the curriculum is an important contextual consideration. Researchers have expressed the concern that oral language skills and literacy skills are often treated as entirely independent skills, and that an emphasis on oral language skills may marginalise the importance of literacy skills (Dunne & Hickey, 2017; Stenson & Hickey, 2018). One contributing factor may be the perception that there is a one-directional relationship from oral language skills to literacy skills, and the belief that as such oral language skills must be prioritised (Dunne & Hickey, 2017). However, there is a reciprocal relationship between oral language and literacy skills; for example, reading increases oral vocabulary (Wasik et al, 2016) and the acquisition of letter-sound rules can aid in understanding pronunciation (Stenson & Hickey, 2018). Importantly - given the context of this study – it is considered that one of the contributing factors to the lack of emphasis on Irish reading ability is the dependence on standardised assessments of literacy in English even in Irish-medium schools (Dunne & Hickey, 2017).

Another significant contextual factor is the extent to which children read for pleasure. Reading for pleasure is correlated with higher levels of literacy attainment (OECD, 2009), and previous research has identified differences in this regard between Gaelscoileanna, Gaeltacht schools and English-medium schools. Importantly, out of the three school types, children in Gaelscoileanna are most likely to read for pleasure, followed by those in Gaeltacht schools and then by those in English-medium schools (MyCoy et al, 2012). Children in Gaelscoileanna are more likely than their peers in English-medium education

[11] Male participants who learned to read using a synthetics phonics approach had better word reading scores and comparable spelling and reading comprehension scores to female participants, while males who learned to read using a mixed methods approach had comparable word reading skills but poorer spelling and reading comprehension skills than the female participants.

to engage in cultural activities (such as drama or music classes), another practice that is positively associated with reading achievement (McCoy et al, 2012).

In terms of early literacy instruction methods, there is reliable and consistent evidence from meta-analyses that phonics-based methods of literacy instruction leads to better reading attainment than unsystematic or no phonics instruction in all children (Camilli et al, 2003; Torgerson et al, 2006) and in poor readers specifically (McArthur et al, 2018; Galuschka et al, 2014)[12]. One of the main contributions of phonics-based instruction in any language is that it confers the ability to decode novel words, a skill that Share (1995) refers to as the *sine qua non* of reading instruction as it allows a child to become an independent reader. The debate in relation to the relative merits of phonics-based and whole-word instruction in foundation literacy is largely the preserve of the English-speaking world (Share, 2008); in transparent orthographies, initial reading instruction is primarily phonics-based (López-Escribano et al, 2018; Landerl et al, 2013, Patel et al, 2004);

In Ireland, though phonics-based instructional methods are typically used to teach English decoding, a whole-word method is often used to teach Irish literacy (Stenson & Hickey, 2014). This is clearly not optimal for Irish; not only in that if fails to exploit the regularity of the orthography, but also because Irish is a highly inflected language, where words appear in many forms. This pedagogical practice appears to stem from a lack of pre-service training in relation to how Irish phonology is represented in the orthography and how to teach the letter-to-sound rules to children (Stenson & Hickey, 2014). This issue is compounded by the fact that the Primary Language Curriculum (National Council for Curriculum and Assessment, 2015) – the language curriculum at primary school level in Ireland - focuses on the transfer of skills from one language to another, and at times this is at the expense of emphasising the need for language-specific phonological and orthographic knowledge (Stenson & Hickey, 2018).

However, recent years have seen some positive changes in this regard, including the development of a comprehensive resource which elucidates the link between Irish phonology and orthography (Stenson & Hickey, 2018) as well as wider availability of phonics-based literacy resources (e.g. *Fónaic na Gaeilge*: Belfast Education and Library Board, 2011; *Mar a Déarfá*: Breacadh, 2012; *Cód na Gaeilge*: CCEA, 2012), and technologies such as *An Scéalaí* (Ní Chiaráin & Ní Chasaide, 2019), which illustrate and

[12] There are some differences in the findings of the various meta-analyses: Galuschka et al (2014) found a small significant effect for spelling as well as reading, whereas McArthur et al (2018) and Torgesen, Brooks and Hall (2006) did not find a significant effect for spelling.

reinforce the main grapheme-phoneme correspondences in Irish, and encourage pupils to self-correct.

As mentioned in the Introduction, an interactive platform called *Lón don Leon* is currently under development in the ABAIR initiative at Trinity College Dublin (Ní Chasaide et al., 2019). This platform provides phonological awareness training on the sound contrasts of Irish, along with early literacy training on grapheme-phoneme correspondence. Some of the activities in this platform exploit the synthetic voices of the ABAIR text-to-speech systems developed for the dialects of Irish (www.abair.ie) as well as the resources in letter-to-sound rules that contributed to the building of these voices (for example, children can create nonwords and hear them pronounced by a synthetic voice in their choice of dialect). It is intended that this platform will provide for a longer-term development, which will accommodate literacy screening tools as well as remediation materials for both new and native speakers of Irish. As mentioned in § 1.4, it is one of the goals of the present work to provide the theoretical and practical underpinning that will guide this development.

An additional positive development over recent years is demonstrated in a study in which extensive reading is promoted (Dunne & Hickey, 2007). In this study, a book club which promoted engagement with a wide variety of texts, with a focus on reading for meaning and for pleasure, was developed and implemented with primary school children. By the end of the programme children chose texts – such as drama texts - that they had little experience of reading previously. Children's qualitative feedback reinforced that they enjoyed the reading club and there was also some surprise expressed at how good the Irish-language reading books were; this is also a testament to the quality of reading materials published in recent years.

The practices of the reading club in this study are in keeping with principles of Universal Design for Learning (e.g. Rose & Meyer, 2006) which promote access providing many means of engagement with learning materials (e.g. comics, dramas, novels; individual reading, group reading) to promote the learning goal (e.g. exposure to reading, increasing reading fluency). This programme also brings to mind the prominent theory of motivation, self-determination theory (Deci & Ryan, 2008), and its principles: autonomy, competence, and relatedness. Children had the opportunity to choose from a range of genres as well as choosing where to sit to read their chosen book (autonomy), the books chosen were appropriate for the age range (competency) and children engaged in pair reading and group reading as well as group discussions (relatedness). These elements also provide a basis for a recently-published resource by Dunne (2021) in relation to reading for pleasure, which contains ideas on promoting reading for pleasure, as well as book recommendations for

primary school students along with practical activities which allow students to get the most out of reading.

2.3.4 Language exposure

Within a dual-language context, another factor which must be considered is the quantity and type of exposure that the beginning reader has with their L2. The experience of individual dual language learners (even within a given language context) differs greatly with respect to the amount of input they receive as well as the way in which they engage with each language (Place & Hoff, 2011; Thordardottir, 2011; Hammer et al, 2014). In young dual-language learners, a number of factors affect language outcomes; these include the amount of input in the majority language, the number and variety of speakers encountered by a dual language learner, the amount of native speaker input a child has and the proficiency of new speakers from whom they receive input (Place & Hoff, 2011; Unsworth et al, 2019).

This effect of language exposure on literacy attainment appears to depend on the type of literacy skill examined. A study of Irish reading comprehension by Harris et al (2006) indicates that a higher degree of parent nativeness in Irish is positively associated with Irish reading comprehension in all school types, and that the frequency of exposure to Irish in the home is associated with higher reading comprehension scores in English-medium, Irish-immersion and Gaeltacht schools (though the difference was not significant in Irish immersion schools). In contrast to this finding in relation to reading comprehension, a recent meta-analysis found no significant difference between the L2 decoding skills of children who had substantial exposure to their L2 in the home and those who did not (Melby-Lervåg & Lervåg, 2014). Differing findings in this regard are not unexpected; reading comprehension is a more complex skill than decoding, encompassing word identification skills as well as language comphrehension skills (Vellutino et al, 2007).

The aforementioned meta-analysis (Melby-Lervåg & Lervåg, 2014) also found that there was no significant difference in L2 phonological awareness between children who had substantial exposure to the L2 at home and those who did not. The meta-analysis, however, did not distinguish between MPA and LPA (as is done in the present study); a focus on the language-specific ability to distinguish between the phonemes of a language may yield different results. Indeed, there is evidence of negative phonological transfer - arising from a lack of distinction between L1 and L2 phonemes - on L2 spelling (Figueredo, 2006).

2.4 Chapter summary

This chapter introduced contextual information pertaining to this thesis. The participants of the study reported in this thesis include both Gaelscoil pupils (who are typically school-generated bilinguals) and Gaeltacht pupils (who are typically home-generated bilinguals). These children learn to read in Irish and English, two languages which have very different phonological and orthographic systems. The demographic variables which affect literacy attainment were also discussed, and are taken into account in the design and interpretation of the study reported in this thesis. The next chapter explores the international literature in relation to the phonological and cognitive tasks that predict literacy, the degree to which they are considered language-universal skills and their efficacy as predictors across languages and in dual-language learners.

CHAPTER 3

LITERATURE REVIEW

As established in the introductory chapter, this thesis explores three main themes, which include (i) the predictors of word reading and spelling in Irish and English (ii) the extent to which these predictors are language-universal and (iii) the nature and construct validity of bilingual phonemic awareness. In this chapter, previous research pertaining to each of these themes is reviewed and explored with a particular focus on language pairs and sociolinguistic contexts which bear similarities to the Irish context.

3.1 The triad of predictors of literacy attainment

Phonemic awareness (PA), rapid automatised naming (RAN) and verbal-short term memory (VSTM) comprise the triad of predictors of literacy attainment (Ramus & Szenkovits, 2008; Peterson et al, 2018). As there is a particular focus in this thesis on the nature and validity of bilingual PA, a more extended account is provided here of PA than of RAN and VSTM.

3.1.1 Phonological awareness and phonemic awareness

The academic study of phonological awareness and its contribution to literacy attainment can be traced back to the work of Russian psychologist D.B. Elkonin (1963), building on research by Shaposhnikov (1925, as cited in Elkonin, 1959) as well as Levina (1940, as cited in Elkonin, 1963). Elkonin defined phonological awareness - then termed 'sound analysis' - as the ability to segment and distinguish between the sounds of language, and highlighted the importance of this skill to foundation literacy development. Later, Isabelle Liberman and her colleagues in Haskins Laboratories (e.g. Liberman et al, 1974) conducted influential research on the construct of phonological awareness in English-speaking children.

Phonological awareness was quite broadly defined as awareness of the phonological structure of speech (Liberman, 1991) or an awareness of the internal sound structure of words (Goswami & Bryant, 1991). There are three levels of phonological awareness: syllable, rhyme (or onset-rime) and phoneme. Phonemic awareness (phonological awareness at the phoneme level) is a more potent predictor of literacy attainment than syllable or rhyme awareness in languages with an alphabetic orthography (Høien et al, 1995) as language is typically represented at the level of the phonemes in alphabetic orthographies (e.g. Ehri et al, 2001). A number of factors underpin the ability to perform PA tasks, including IQ, verbal short-term memory and categorical perception of

phonemes[13] (McBride-Chang, 1995), letter name knowledge (Evans et al, 2006) as well as attention and the ability to follow task instructions (Cunningham, 2015).

Tasks used to measure PA. PA is defined largely by the tasks used to measure it (Stahl & Murray, 1994; Castles & Coltheart, 2004). PA tasks typically require the participant to perform an explicit manipulation of phonemes (e.g. to segment, blend, isolate or delete phonemes) or to make a judgement on phonemes (e.g. decide whether two words begin with the same phoneme; Hulme et al, 2005). The tasks used to measure PA differ in a number of important ways which affect their relative difficulty and as such, their usefulness as a measure of PA for a given age group (Schatschneider et al, 1999).

The first factor that differentiates between PA tasks is the type of PA it taps. Based on Gombert's (1992) account of the development of metalinguistic awareness, some researchers have made the distinction between linguistic and metalinguistic PA (Duncan et al, 1997; Saiegh-Haddad, 2007). Linguistic PA is primarily unconscious in nature and is involved in intuitive phonological judgements, while metalinguistic PA involves performing a conscious operation on a phonological unit[14]. Recently, Saiegh-Haddad (2019) contended that these two aspects of PA give rise to a language-specific component of PA as well as a language-universal one, a claim tested in the present study.

The second factor that affects the difficulty level of PA tasks is the cognitive demands they impose, particularly on memory. While all tasks require the identification or manipulation of a phoneme, certain tasks (including phoneme deletion and phoneme matching tasks) place a higher demand on working memory, as the participant is required to hold a given sound in memory while performing an operation on it or making a judgement on it (Yopp, 1988). Additionally, tasks may have an open-ended response format or a forced choice response format (McBride-Chang, 1995) and the type of response format can affect the relationship between PA and reading attainment (Cunningham et al, 2015)[15].

The third factor that affects the difficulty level of PA tasks is the nature of the stimuli included in the tasks. The position of a phoneme, the type of phoneme, the total number of phonemes, and the number of consonants in a consonant cluster affect performance on PA tasks (Stahl & Murray, 1994; McBride-Chang, 1995; Chafouleas et al, 2001). In phoneme

[13] Categorical perception was measured by a task assessing the perception of Voice Onset Time in the context of word-initial /b/ and /p/ in minimal pairs.

[14] In Saiegh-Haddad (2007), linguistic PA was operationalised using a phoneme recognition task – requiring the participant to indicate whether a pseudoword begins with a given phoneme - while metalinguistic PA was operationalised using a phoneme segmentation task, requiring the participant to segment a spoken word into its constituent phonemes.

[15] In Cunningham and colleagues' (2015) study, participants completed PA tasks with a verbal response and PA tasks with a forced-choice non-verbal response. Scores on the verbal response tasks accounted for unique variance in decoding over and above that accounted for by scores on the verbal response tasks.

identification tasks (which require a participant to decide whether a word begins with a target phoneme), it has been found that the degree of similarity between two phonemes affects performance: phonemes that differ only in voicing are more difficult to differentiate than those that differ in terms of place of articulation or in in both voicing and place of articulation (Treiman et al, 1998). In addition, nonword stimuli appear to be more challenging than real word stimuli (Szenkovits & Ramus, 2005).

In sum, the difficulty level of a PA tasks is affected by the cognitive demands of the task as well as the nature of the stimuli it comprises. Of particular importance in the context of bilingual PA is the distinction made between LPA (which is language-specific) and MPA (which is language-universal) by some researchers, though this has been underacknowledged in the literature generally.

The relationship between PA and reading: direction and causation. The ability to explicitly analyse the phonemes in a spoken word is not one that arises naturally, as speech is not easily segmented into phonemes at the acoustic level (Liberman et al, 1974). This leads to questions in relation to the directionality of the relationship between PA. In early work on PA, Liberman acknowledged both the phonological and orthographic contribution to performance on PA tasks: she observed that children have more difficulty with the segmentation of vowels than of consonants, and attributed it to both orthographic complexity (there are multiple ways to spell a given vowel) and its more continuous (non-categorial) nature in speech which renders the vowel a less definite phonological entity than a consonant in English (Liberman, 1973).

The possibility of a causal link between PA and reading was later proposed, though it was done in a tentative manner (Mann & Liberman, 1984). There is a lack of consensus among researchers in this regard: some view the relationship between PA and reading as causal (e.g. Wagner & Torgesen, 1987; Hulme et al, 2005; Caravolas et al, 2012), some see literacy instruction as the main catalyst for PA development, though PA ability builds on existing phonological representations (e.g. Duncan et al, 1997; Mann & Wimmer, 2002) and many view the relationship between PA and reading as reciprocal (e.g. Perfetti et al, 1987; Ziegler & Goswami, 2005). Indeed, a reciprocal relationship between PA and reading is supported statistically in longitudinal studies in which PA predicted later literacy attainment, and literacy attainment predicted later PA (Wagner, Torgesen & Rashotte, 1994; Burgess & Lonigan, 1998; Peterson et al, 2018).

Orthographic effects on PA. A different interpretation of the relationship was provided by Castles and Coltheart (2004), who propose that literacy instruction changes the way in which children perform PA tasks, allowing them to use orthographic information

to arrive at an answer. Indeed, there is evidence of orthographic effects on responses to both MPA tasks[16] (phoneme deletion; Castles et al, 2003) and LPA tasks[17] (phoneme identification; Castles et al; 2011). There is also fMRI data indicating that orthographic representations are activated in the brain in phonological awareness tasks even in 5-6 year old children[18] (Wang et al, 2018). The extent to which orthographic representations are available in the mental lexicon appears to be an element of what is measured by PA tasks, as children who are better spellers are more likely to use an orthographic strategy to complete a Phoneme Deletion task (Stuart, 1990). Within this perspective, it is not surprising that PA tasks correlate with literacy attainment as they are essentially an indirect measure of orthographic ability.

Castles and Coltheart (2004) emphasise that it is the ability to acquire grapheme-phoneme correspondences that is crucial to literacy attainment, rather than a fundamentally phonological skill. As evidence, they review intervention studies and state that no study has conclusively proved that PA training alone improves subsequent literacy skills in children who had not been exposed to phonics-based literacy instruction. Indeed, a recent meta-analysis of reading interventions indicates that while phonics-based interventions are effective in ameliorating poor reading skills, PA training alone is not in children learning to read in their L1 (Galushcka, 2014). In a response to Castles and Coltheart's (2004) article, Hulme and colleagues (2005) defend the causal relationship from PA to literacy attainment[19], though they argue that a unidirectional causal link between PA and reading is simplistic. Instead they propose that there is a reciprocal relationship between PA and letter knowledge, and that both are causally related to literacy attainment.

[16] In this study (Castles et al, 2003), adults were significantly better at deleting phonemes from orthographically-transparent words (in which there is a direct correspondence between phonemes and graphemes) than orthographically-opaque words. Opaque words included those with silent letters e.g. *knuckle* or those with biphonemic graphemes e.g. *fox.* The phoneme deletion task contained 45 opaque and 45 transparent stimuli.

[17] In this study (Castles et al, 2011), children were trained on certain letter-sound correspondences and were significantly better at identifying phonemes for which they were taught the corresponding grapheme than those they were not.

[18] In this study (Wang et al, 2018), the level of activation in the left ventral occipitotemporal cortex was examined – proposed to be involved in processing letters – during phonemic awareness and rime awareness tasks. Higher reading ability was associated with higher sensitivity in this region for the phonemic awareness task, but not the rime awareness task.

[19] Hulme and colleagues (2005) also dispute the argument that PA is not dependent on orthographic knowledge, as children can isolate a phoneme which they do not know the name or sound for (i.e. if the child does not know the sound or name for the letter <t>, they can still isolate /t/ from a word). This argument, however, is unconvincing as phoneme isolation tasks typically require the metalinguistic ability to separate words into phonemes, rather than a specific linguistic or graphophonemic skill which requires explicit knowledge of a letter and its corresponding phoneme.

In sum, the balance of evidence suggests that the relationship between PA and literacy attainment is reciprocal, and that both metalinguistic PA and linguistic PA are affected by orthographic representations.

3.1.2 Rapid automatised naming

Rapid automatised naming (RAN) tasks assess the speed and accuracy with which a series of visual objects are named (Denckla & Rudel, 1974). Though the format of RAN tasks is consistent across studies, the content may include colours, numbers, letters or objects. RAN is considered a phonological processing task (Wagner & Torgesen, 1987; Melby-Lervåg et al, 2012), however there is ample evidence that RAN taps an ability that is independent of phonology (Wolf & Bowers, 1999; Manis et al, 1999; Clarke et al, 2005; Arnell et al, 2009; Wolff, 2014).

One of the most compelling conceptualisations of RAN tasks is as a microcosm of the reading process (Norton & Wolf, 2012), such a view emphasises the importance of automaticity within and across components in the naming circuit. Building on a model of word and nonword reading by Seidenberg & McClelland (1989), Manis, Seidenberg and Doi (1999) posit that there are three components which are central to RAN performance. The first is the quality of visual representations (of an object, digit or letter depending on the type of RAN task), the second is the quality of phonological representations and the third is connections between orthographic and phonological representations. They also suggest that impairments in one of the components of the model affects the speed of processing, based on connectionist models of reading by Harm & Seidenberg (1999). This indicates that there are multiple pathways to a similar phenotype.

Studies which examine the contribution of PA and RAN to various subskills have found that RAN is a better predictor of skills for which access to a lexical or orthographic representation is necessary, whereas PA is a better predictor of skills for which knowledge of grapheme-phoneme correspondences is necessary (Wolff, 2014; Manis et al, 1999). In terms of reading subskills, PA appears to be more important to nonword reading (Clarke et al, 2005; Georgiou et al, 2008) and spelling (Furnes & Samuellson, 2010) than word reading. This is an intuitive finding when the more fundamentally phonological demands of nonword reading (phonological decoding) and spelling are considered. Studies which examine different reading tasks separately have found that RAN appears to be a stronger predictor of reading speed than of reading accuracy (Mann & Wimmer, 2002; Moll et al, 2014; Ziegler et al, 2010). This is also a logical finding when RAN tasks are interpreted as a measure of the automaticity of phonological-orthographic connections (Norton & Wolf, 2012).

3.1.3 Verbal short-term memory

The construct of verbal short-term memory can be framed within the phonological loop component of Baddeley and Hitch's (1984) conceptualisation of short-term memory. Their account allows for the distinction between verbal short-term memory - which involves the temporary storage of information - and working memory, in which an operation is performed on the stored information (Baddeley & Hitch 1984; Baddeley, 2003). The phonological loop consists of both a temporary storage system and a subvocal rehearsal system, which maintains information in storage and registers visual representations within the store, if such representations are available (Baddeley, 2003). It has been proposed that the phonological loop is essentially a language-learning device in which novel phonological forms are stored temporarily to support the construction of long-term representations (Baddeley et al, 1998).

In literacy-related research, VSTM is typically operationalised with a digit span task, which requires the participant to listen to a list of digits and recall them in the correct order. Though consistently investigated as a predictor of reading, a recent meta-analysis found that verbal short-term memory is a less effective predictor of reading than phonological awareness and is not a unique predictor of reading when phonological awareness is controlled for (Melby-Lervåg et al, 2012). This reflects the findings of individual cross-linguistic studies which have found that verbal short-term memory does not uniquely predict literacy attainment (Parrila et al, 2004; Mann & Wimmer, 2002; Caravolas et al, 2012; Vaessen et al, 2010) or that it is an inconsistent and relatively weak predictor of reading accuracy across languages (Ziegler et al, 2010). It is suggested by various researchers (de Jong & der Leij, 1999; Parrila et al, 2004) that verbal short-term memory shares its predictive variance with phonological awareness, and as such it does not emerge as a unique predictor of reading in statistical analysis in which PA is entered. This is supported by the finding that verbal short-term memory accounts for a significant amount of variance in PA skill (McBride-Chang, 1995).

It is not yet clear how the relationship between short-term memory and literacy attainment should be conceptualised. Some researchers view verbal short-term memory deficits as a reflection of the quality of phonological representations (Melby-Lervåg & Hulme, 2010). Research into VSTM deficits indicates that there are multiple contributing factors including poorer phonetic coding, a less effective phonological storage buffer, slower articulation rate and poorer quality retrieval from long-term memory (Kibby, 2009). In light of evidence that memory order but not item information is impaired in people with dyslexia, other researchers consider that a deficit in short-term memory may reflect an issue with the

sequencing of information rather than with the storage of information itself (Hachmann et al, 2014).

3.1.4 Conceptualising the predictors of literacy attainment: insight from dyslexia research

Though this study is not directly concerned with dyslexia, examining the link between dyslexia and the construct of PA, RAN and VSTM provides insight into what these tasks measure and how they contribute to literacy attainment. The dominant view in the literature is that dyslexia arises from a deficit in phonological processing. However, there are a number of shortcomings of this theory, and a more recent theory of a deficit in phonological-orthographic binding is also examined in this section.

Phonological processing. In addition to phonological awareness, early experiments showed that there was a significant difference between good and poor readers in auditory memory (remembering a string of letters presented auditorily: Torgesen & Goldman, 1977). This was interpreted as a deficit in phonetic coding in working memory, possibly resulting from a lack of verbal rehearsal (Katz et al, 1981; Liberman, 1989). Around the same period, Denkla and Rudel (1976) found that children with dyslexia had a slower reaction time on RAN tasks than typical readers, which they interpreted as a deficit in the automatisation of verbal responses to visual stimuli.

It was proposed that there was a relationship between phonological awareness, phonological recoding in lexical access (RAN) and phonological recoding in working memory, and these skills were subsumed under the umbrella of phonological processing (Wagner & Torgesen, 1987; Szenkovitz & Ramus, 2005). RAN tasks and memory tasks have also been characterised as implicit phonological tasks, which contrast with the explicit phonological tasks which measure phonological awareness (Melby-Lervåg et al, 2012). It was theorised that poor readers had a general deficit in phonological skills (Liberman, 1991) and that dyslexia stemmed from a core phonological deficit (see Snowling, 1998 for a review). The phonological deficit hypothesis has been the dominant theory in recent years (Thompson et al, 2015).

However, there a number of shortcomings with a purely phonological explanation. The first is that exposure to literacy instruction is necessary for PA development (Morais et al, 1987; Bruck and Genessee, 1995), and PA tasks show influence from orthographic representations (see § 3.1.1). The second is that conceptualising RAN as a measure of phonological representations is reductive, given that it is separable from a phonological construct and relates more closely to reading tasks which require orthographic representations (see § 3.1.3). The third is that a phonological explanation fails to effectively

account for the slow but accurate reading which characterises dyslexia in more transparent orthographies (e.g. Serrano & Defior, 2008; Davies et al, 2007). The fourth is that spelling errors made by people with dyslexia are often phonologically-plausible (e.g. Protopapas et al, 2013; Daigle et al, 2016).

The orthographic-phonological binding theory. An alternative theory was suggested by Blomert (2011), who stated that dyslexia results from a "specific audiovisual binding deficit". In this view, early reading failure results from a failure to establish stable connections between brain areas involved in letter and speech sound processing. Blomert (2011) bases his argument on neurobiological findings which show that children and adults with dyslexia show a reduced response to letter-sound integration[20] when compared to non-dyslexic peers (Blau et al, 2009; 2010). In children, activation relevant for letter-sound integration explained 40% of the variance in reading performance, and the response to phonemes in isolation did not explain any additional variance (Blau et al, 2010[21]). Blomert (2011) tentatively speculates that similar audiovisual associations also exist for larger grain sizes (e.g. at the word level). Indeed, this result was recently obtained at the word level in a small study of Chinese readers (Yang et al, 2020), in which it was found that activation in areas responsible for audiovisual integration accounted for 70% of the variance in Chinese reading performance.

Successful binding of information from two modalities is dependent on temporal processing. A recent meta-analysis (Meilleur et al, 2020) examined the role of temporal processing, which is crucial for the integration of information across different modalities (e.g. between the auditory and visual modalities) in people with dyslexia. The binding of two stimuli from separate modalities is dependent on the level of temporal synchronicity between them. The temporal binding window (TBW) describes the period of time within which two stimuli from different modalities are likely to be perceptually bound: a narrower TBW is more likely to result in the successful binding of two stimuli. (Stevenson et al, 2013). The meta-analysis of 17 studies in relation to temporal processing in dyslexia found that temporal processing in auditory, visual and tactile modalities was impaired, as was multimodal temporal processing, compared to control groups (Meilleur et al, 2020). There

[20] Interestingly, while normal readers supressed incongruent letter-sound pairs, in the dyslexic group, incongruent and congruent letter-sound pairs produced equivalent activation patterns (Blau et al, 2009).
[21] In this study, fMRI data was used to analyse patterns of brain activation and dyslexic participants and controls during tasks involving letters and/or sounds. Using regression analysis, the researchers found that activation in brain regions involved in letter-sound binding (planum temporale/Heschl sulcus) and activation in brain regions involved in letter recognition (fusiform gyrus) accounted for almost 40% of the variance in reading attainment. Activation in brain regions involved in speech sound processing did not account for any additional variance (Blau et al, 2010)

was also a positive correlation between temporal processing and the degree to which reading was impaired in individuals, though it was small (r = .27).

Though Blomert's theory focuses on the automaticity of auditory-visual connections as the main deficit in readers with dyslexia, other researchers suggest that there are multiple pathways to the same phenotype (Francisco et al, 2017). Indeed, a temporal processing training study found that increasing visual training (a single modality) narrowed the multimodal TBW (Stevenson et al, 2013). This indicates that there is a relationship between multimodal binding and the underlying modalities. This is in keeping with the simulations of connectionist models of reading which suggest that impairments in either orthographic representations, phonological representations or the connections between them can result in a similar deficit in word reading (Harm & Seidenberg, 1999).

The main strength of Blomert's phonological-orthographic binding theory is that it explains what the phonological deficit theory fails to. The failure to bind orthographic and phonological forms can explain the slow but accurate reading of people with dyslexia in transparent orthographies, which is difficult to account for with a purely phonological explanation. It can also explain both the relationship between PA and reading, and RAN and reading. Given that exposure to literacy instruction is necessary to complete PA tasks (Morais et al, 1989; Bruck and Genessee, 1995), and given that PA tasks show influence from orthographic representations (Stuart, 1990), it is reasonable to suggest that PA could be considered – partially, at least - as a measure of letter-sound integration. In addition, the conceptualisation of RAN as a measure of the automaticity of phonological-orthographic correspondences (Norton & Wolf, 2012) is more plausible than a purely phonological explanation, given that it is a separable construct (Wolf et al, 1999).

3.2 Language-universal and language-specific contributions to dual-language skills

Having established the nature of the predictors in a single-language context, it is now necessary to examine the extent to which the predictors of literacy – as well as literacy skills themselves – can be considered language-universal. This examination is grounded in two frameworks, each of which posits that these skills are language-universal. The first is the common underlying proficiency (CUP) model was developed by Cummins (1981) and underpins his interdependence hypothesis[22] (Cummins, 1979). The CUP states that there is a shared proficiency between both of a bilingual's languages: provided that there is adequate motivation to learn and adequate exposure to both languages, learning experiences within either language can result in the development of the proficiency

[22] The developmental interdependence hypothesis posits that the level of competence a child attains in their L2 is partially dependent on their competence in their L1 at the time of exposure to their L2.

underlying both languages. Cummins suggests that the degree of typological relatedness of two languages affects the amount of transfer that occurs; in dissimilar languages transfer consists of conceptual and cognitive elements, while linguistic elements may also be transferred in languages with similar linguistic structures (Cummins, 2005).

The ability of pupils in dual language education to become literate in two languages in the time it takes for a monolingual student to become literate in one has been attributed, at least in part, to a shared underlying proficiency across languages (e.g. Wagner et al, 1989; Turnbull et al, 2001; Parsons & Lyddy, 2016). Though there is much support for the CUP, critics have noted that the constructs and relationships proposed in the CUP model are underspecified and consider it applicable only to procedural skills in each language (Genesee et al, 2006). In addition, while other models of dual-language learning acknowledge the presence of negative transfer (e.g. the contrastive-typological framework: Lado, 1957; the Unified Competition Model: MacWhinney, 2005) the CUP model does not.

The second framework is the common underlying cognitive processes theory (CUCP) (Geva & Ryan, 1993; Geva et al, 2019), which extends the theory of a shared proficiency to the cognitive and linguistic skills which underpin literacy development. This theory states that general processing skills such as working memory, phonological awareness and RAN *underlie* L1-L2 reading processes rather than transferring across them. Though L1-L2 distance is considered by some to constrain cross-linguistic transfer (e.g. Koda, 2008; Saiegh-Haddad, 2017), it is contended by Chung, Chen and Geva (2019) that PA transfers across languages regardless of L1-L2 distance or L2 proficiency. Importantly, the CUCP framework has implications for predicting reading; the CUCP posits that individual differences in L1 and L2 reading skill can be predicted by a common set of cognitive constructs (i.e. PA, RAN and working memory), and that these constructs are not malleable (Chung et al, 2019).

3.2.1 Literacy attainment

In order to maximise the relevance of findings to the present thesis[23], the discussion in this section is limited to studies pertaining to Irish-English and French-English dual-language learners' experience in Ireland and Canada respectively. The supportive language-learning environment in this context as well as the similar level of orthographic depth in Irish and French make it more comparable to the Irish context.

[23] Much of the existing literature – 84%, according to a review by Hammer and colleagues' (2014) review - pertains to children learning English as a second language. Of these, the majority are studies conducted in the United States with children from a low-SES background.

Within the Irish context, there is reliable evidence of positive outcomes in relation to English literacy attainment in both Gaelscoil and Gaeltacht pupils (Parsons & Lyddy, 2016). Gaelscoil pupils perform as well as their English-medium (EM) peers in English word reading, nonword reading and vocabulary by their fourth year of schooling, and Gaeltacht pupils perform as well as their EM peers in nonword reading and vocabulary by the fourth year of schooling, though they still have lower word reading scores. Given the limited exposure of Gaelscoil and Gaeltacht pupils to English during the school day, the ability to become literate in two complex languages and score comparably to L1 speakers in each language is likely to be attributable – at least in part – to the cross-linguistic transfer of skills (Parsons & Lyddy, 2016).

These findings in relation to Irish immersion students' literacy development is mirrored by those of their French immersion counterparts in Canada, who experience a short-term lag in development in English literacy skills compared to their English-medium peers (Genesee & Jared, 2008). Empirical studies show that though total French immersion pupils perform below their EM peers before they begin English reading instruction Grade 3 (Turnbull et al, 2001), they outperform their EM peers in Grade 6 (Turnbull et al, 2003). The researchers propose that immersion students quickly catch up to those in EM programs given a low threshold amount of English language instruction, though they also state that these results may be affected by the attrition of some students with additional learning needs[24] or a lower educational ability to English-medium programs (Turnbull et al, 2003). This is a situation paralleled in the Irish context; Nic Aindriú and colleagues (2020) found that there are less pupils with special educational needs enrolled in Gaelscoileanna than in English-medium schools.

Though there is evidence of a common underlying proficiency supporting literacy acquisition in the Irish context, there is some evidence of negative transfer at the task level. For example, Hickey (2005) found that word reading errors made by L2 learners of Irish in English-medium schools showed influence from English grapheme-phoneme rules and from English letter names. Similarly, Parsons & Lyddy (2009) found that when reading Irish words, children in EM schools, Gaelscoileanna and Gaeltacht schools made English word substitutions (e.g. the Irish word <cé> - pronounced /cʲeː/ - read as the English word 'see'). However, there were no Irish word substitutions on English word reading tasks, suggesting a dominance of English reading skills in Grade 4 (Second Class). Note,

[24] An earlier study (Genesee, 1978) provides insight on the matter of low-performing students in immersion programmes, indicating that those with below average IQ perform as well as their peers in English-medium programs (also with below average IQ) in tests of English language and writing. This study also shows a similar pattern of an initial lag in literacy skills (reading comprehension and spelling) compared to those in English-medium education, which dissipates over time.

however, that transfer from English has been noted on the Irish spelling of children in a Gaelscoil beginning reading instruction in English in Grade 3 (e.g. spelling the word *called* as <cáld>; Ní Mhathúna, 2018).

Overall, these findings suggest that there is evidence of a common underlying proficiency that facilitates dual-language literacy attainment at the macro level, but also of some negative transfer at the micro level which can be ameliorated given sufficient language-specific instruction.

3.2.2 Phonemic awareness

PA is widely considered to be a language-universal skill (Au-Yeung et al, 2008). Those that support a language-universal conceptualisation of PA cite correlational evidence (e.g. Chung et al, 2019), though this evidence is inconclusive and inconsistent across languages. Meta-analyses indicate that overall, there is a moderate correlation between PA in each of a bilingual's languages (Melby-Lervåg & Lervåg, 2011), and that there is a significant difference between the strength of the relationship between PA across each of a bilingual's languages, ranging from a weak correlation (r = .39 in Mandarin-English and Hebrew-English language pairs) to a high correlation (r = .86 in French-English language pairs; Branum-Martin et al, 2012).

It is tempting to deduce that variation in the strength of these correlations is purely due to the differing language pairs, however, it may also be influenced by the tasks used in the studies. The distinction between metalinguistic and linguistic tasks is not acknowledged in the meta-analyses[25] (Melby-Lervåg & Lervåg, 2011; Branum-Martin et al, 2012), which include studies which use a range of tasks, including tasks which are essentially metalinguistic (segmenting, blending, deleting) and fundamentally linguistic (providing a judgement on a phoneme). Tasks which tap the metalinguistic component are most commonly used (see, for example, the studies included in Branum-Martin et al, 2012) despite evidence suggesting that the linguistic component of PA also influences literacy development.

The linguistic component of PA – particularly the ability to distinguish perceptually between L2 phonemes which do not exist or are non-contrastive in the L1 - is particularly important for L2 spelling. A number of studies have found that errors in L2 perception have led to phonologically-influenced spelling errors (Wang & Geva, 2003). This occurs across

[25] Branum-Martin and colleagues (2012) attempted to investigate whether task type had a significant effect on the strength of the correlation, however the models did not have significant estimates; the authors suggest that this may be a true finding or that it may result from the sample size being too limited. This appears to have been an examination of each task type separately, rather than an investigation of metalinguistic type tasks compared to linguistic type tasks.

a broad range of languages: for example, /z/ may be misspelled by L1 Spanish-speaking children as <s> or <c> as /z/ and /s/ are non-contrastive in Spanish (Cronnell, 1985; Zutell & Allen, 1988). Similarly, Japanese adults were found to substitute <r> for <l> in English words such as *salary* and *global* due to the lack of /r/-/l/ contrast in Japanese (Cook, 1997). In addition, Arabic-speaking children had more trouble than native English speakers spelling /p/ and /v/, which do not occur in Arabic, often being replaced with the grapheme representing the closest phoneme in their L1 (/b/ and /f/). Finally, native Cantonese speakers made more errors when attempting to spell /θ/ - a phoneme that does not occur in Cantonese - than L1 English speaking children, though this group difference disappeared in Grade 2 (Wang & Geva, 2003).

Importantly, the nature of the orthography has been found to influence the development of L2 phonological representations. Transparent orthographic representations facilitate the acquisition of novel phonemes (Escudero et al, 2008), while acquiring an L2 phonemic contrast which does not occur in the L1 can be hindered by opaque orthographic forms (Escudero et al, 2014)[26]. In sum, though PA has typically been considered a language-universal skill, more recent research by Saiegh-Haddad (2019) in particular has emphasised the importance of language-specific phonological awareness. There is ample evidence from studies of L2 spelling that this language-specific component is an important factor in L2 literacy development.

3.2.3 Rapid automatised naming

Studies which compare RAN scores in each of a bilingual's languages indicate that bilinguals are slower at naming items in their non-dominant language than in their dominant language (Gollan et al, 2008; Pae et al, 2009)[27]. This finding is paralleled in language-learning; more fluent learners of a language are faster at naming than less fluent learners of a language (Kroll et al, 2002). In addition, the RAN scores of bilinguals are not likely to be comparable to monolingual norms; overall, bilinguals appear to be slower at naming than monolinguals, even in their dominant language (Ivanova & Costa, 2008; Bialystok et al, 2008; Sandoval et al, 2010).

[26] In this study (Escudero et al, 2014) of native Spanish speakers, half the participants were exposed to only the audio of pseudowords (*audio* group), while half saw an orthographic representation of the pseudoword also (*audio + orthography* group). Participants were exposed to orthographically congruent contrasts (in which the same grapheme-phoneme correspondences were used to represent a similar contrast in both Dutch and Spanish) and orthographically incongruent contrasts (e.g. the phonemic contrast /ɪ/-/i/ exists in Dutch but not in Spanish, in which only /i/ forms part of the phonemic inventory. In Dutch, /ɪ/ is represented by the grapheme <i> and /i/ by the grapheme <ie>; in contrast in Spanish /i/ is represented by the grapheme /i/). The *audio + orthography* group performed better than the *audio* group on orthographically congruent pairs, but performed worse than the *audio group* on incongruent pairs.

[27] A number of studies examine RAN or lexical fluency in both of a bilingual's languages (e.g. Gollan et al, 2005), however they focus on between-group (monolingual-bilingual comparisons) and as such, do not control for length of articulation across languages.

To account for the bilingual disadvantage in lexical fluency, researchers have proposed the weaker links hypothesis, which posits that the less frequent use of each language by bilinguals (compared to monolinguals) results in weaker links between semantic and phonological components of lexical representations (Gollan et al, 2008)[28]. This is essentially a frequency effect (Ivanova & Costa, 2008). Though this hypothesis relates to between-group findings (monolingual vs bilingual), it could reasonably be extended to findings that bilinguals have higher lexical fluency in their dominant language due to relatively higher use of their dominant language. In sum, though RAN is included in the CUCP framework, previous studies suggest that RAN is highly susceptible to frequency effects and that naming speed differs significantly in each of a bilingual's languages.

3.2.4 Verbal short-term memory

Very few studies have examined verbal-short term memory using equivalent or comparable tasks in each language, though fortunately there has been one study relating to short-term verbal memory in the Irish context. McVeigh, Wylie and Mulhern (2019) examined the short-term verbal memory of pupils (7 and 9 years old) in Irish immersion education in Northern Ireland. They compared the performance of pupils in Irish and English and found no significant difference between scores on the Irish and English versions of the word recall task (comparable to the VSTM measure used in this study)[29]. Importantly for the present thesis, the authors suggest that this has implications for assessment in dual-language education environments and that – based on these findings – scores on simple measures of VSTM in one language can be expected to hold in the other language.

Another study (Thorn & Gathercole, 1999) found differing results for those in part-time French-medium education and those in full-time French medium education. For native (French-English) bilinguals, there was no significant difference between performance on the English and French digit recall task. The same finding obtained for sequential bilinguals who attended French-medium school full-time. However, sequential bilinguals who attended a part-time French school (between one hour and one day per week) had significantly better performance on the English version of a digit recall task, than on the French version. This perhaps supports the threshold hypothesis (Cummins, 1981) which

[28] Later, the same group of researchers (Sandoval et al, 2010) also indicated that dual-language activation is likely to play a role in the bilingual disadvantage in lexical fluency. However, this is less relevant to comparisons between each language of a bilingual.

[29] They also compared performance of pupils on three working memory tasks and found that there was only a significant difference between the Irish and English version of the most challenging of the three tasks (listening recall task). The three working memory tasks were (i) listening recall task: participant listens to a series of spoken sentences, indicates whether they are true or false and then recalls the final word in the sentence (ii) counting recall task: participant counts the number of circles on the screen in a series of sets, and then recalls the number of circles in each set (iii) backward digit recall: participant listens to a list of digits and recalls the list in reverse order.

states that a threshold level of linguistic competence is necessary before the cognitive influence of bilingualism is discernible.

Together, these findings suggest that VSTM is a language-universal ability, provided that a threshold of linguistic competence (or a threshold level of familiarity with the stimuli type) is achieved. Given the very small number of relevant studies in this area, additional studies are necessary to confirm and extend these findings.

3.2.5 Summary

There is evidence of a common underlying proficiency that supports the development of literacy skills in Irish-English and French-English bilinguals, though there is also evidence of negative transfer at the task level. Though PA is typically considered a language-universal skill (e.g. Chung et al, 2019), correlational evidence indicates that the relationship between PA in each of a bilingual's languages is highly variable (yielding weak correlations in some language pairs and high correlations in others; Branum-Martin et al, 2012). With regard to cognitive abilities, while VSTM appears to be a language-universal ability once a low threshold of language competence is attained, previous studies indicate that RAN is a language-specific skill and is highly influenced by frequency effects.

3.3 The efficacy of predictors of literacy attainment

Having examined the nature of the predictors PA, RAN and VSTM and their language-universality, this section examines their predictive efficacy. The findings of studies which examine the predictors of literacy attainment in native speakers of various languages (within their native language only) are explored in § 3.3.1. Then, findings of studies which investigate the predictors of literacy attainment in dual-language learners are examined in § 3.3.2.

3.3.1 Predictive efficacy in different alphabetic languages

An overview of methodological elements of studies investigating the predictors of literacy in multiple alphabetic orthographies is provided in Table 3. The pattern of predictors of literacy attainment in different languages provides evidence in relation to the universality of the cognitive mechanisms underpinning reading in each language (Landerl et al, 2019). If the same pattern of predictors predict literacy attainment to the same extent in different languages, it could be concluded that the role that cognitive abilities play in literacy development is equivalent in each language. In contrast, if different patterns of predictors are found in each language, or if predictors predict literacy attainment to a different extent, it could be surmised that the cognitive abilities underpinning reading in each language differ either quantitatively, qualitatively or both.

Table 3
Studies investigating the predictors of dual-language literacy attainment: patterns of predictors across languages

Author	Language groups	Ages	Predictors investigated	Literacy attainment measure	Statistical analysis	Cross-linguistic difference found? (✓ = different; X = same)	
Mann & Wimmer, 2002	German & English	Grade 1 & 2 combined	Phonological awareness RAN Phonological short-term memory	Word and nonword reading speed	Stepwise regression (separate models for each language)	✓	Different pattern
				Word and nonword reading accuracy		✓	Different pattern
Patel et al, 2004	Dutch & English	Large age range spanning 4-5 grades	Phonological awareness RAN Vocabulary	Word reading accuracy	Hierarchical regression (separate models)	✓	Different pattern
				Word reading speed	(same model)	X	Same pattern
				Nonword reading accuracy	(same model)	X	Same pattern
				Nonword reading speed	(Same model)	X	Same pattern
Caravolas et al, 2005	Czech & English	Czech: Grades 2-5 English: Grades 2 -7	Phonological awareness Speed of processing (coding) Vocabulary Phonological short-term memory IQ	Word reading speed	Structural equation modelling (same model)	X	Same pattern
				spelling		X	Same pattern
Georgiou et al, 2008	Greek & English	Grade 1 & 2	Phonological awareness RAN Phonological short-term memory Orthographic choice	Word reading fluency	Structural equation modelling (separate models)	✓	Different pattern
				Phonological decoding		✓	Different pattern
Ziegler et al, 2010	Finnish, Hungarian,	Grade 2	Phonological awareness RAN	Word reading speed		✓	Different patterns for some languages

	Netherlands, Portugal France		Phonological Short-term memory Nonverbal IQ	Word reading accuracy Decoding speed Decoding accuracy	Regression (separate models)	✓ ✓ ✓	Different patterns for some languages Different patterns for some languages Different patterns for some languages
Furnes & Samuellson, 2010	Norwegian, Swedish & English	Grade 1&2	Phonological awareness RAN Vocabulary	Word reading fluency Phonological decoding spelling	Regression analysis (separate models)	✓ ✓ ✓	Different pattern Different pattern Different pattern
Vaessen et al, 2010	Dutch, Portuguese, Hungarian	Grade 1, 2, 3 & 4	Phonological awareness RAN Letter-sound knowledge Working memory	Word reading fluency	Regression analysis (same model)	✓	Same pattern though strength of predictor varied across languages
Caravolas et al, 2012	English, Spanish, Czech & Slovak	Grade 1	Phonological awareness RAN Letter knowledge Phonological short-term memory	Word reading fluency & picture-word matching test Spelling	Structural equation modelling (same model)	X X	Same pattern of predictors & same strength in each language Same pattern of predictors & same strength in each language
López-Escribano, et al, 2018	Bulgarian & Spanish	Grade 1 & 2	Phonological Awareness RAN Vocabulary	Reading speed	Regression analysis (separate model)	✓	Same pattern though strength of predictor varied across languages
Landerl et al, 2018	English, French, German, Dutch, Greek	Grade 1 & 2	Phonological awareness RAN	Word and nonword reading fluency	Path analysis (separate models: universal model not a good fit)	✓	Different pattern of predictors

Though there are contrasting findings in the literature, the majority of the evidence suggests that there are differences in the pattern of cognitive and phonological skills which predict literacy in various languages or in the extent to which these skills predict literacy attainment in each language (Mann & Wimmer, 2002; Georgiou et al, 2008; Ziegler et al, 2010; Furnes & Samuellson, 2010; Vaessen et al, 2010; López-Escribano et al, 2018; Landerl et al, 2018). In most of these studies (except Vaessen et al, 2010: discussed below), separate statistical models were reported for each language.

Two studies have found that the pattern of predictors are the same in each language, and that the efficacy of these predictors are equivalent in each language (Caravolas et al, 2005; Caravolas et al, 2012). In these studies, a single (multigroup) model was established and deemed to fit each language well. Another study found cross-linguistic differences in word reading accuracy but not word reading speed or nonword reading speed or accuracy (Patel et al, 2004). In this small-scale study, a single model was established for all languages and separate models were only reported for word reading accuracy as there was a significant interaction between language and phonemic awareness.

The contrasting findings in these studies may be explained – at least in part – by the different statistical analysis methods used. A study by Furnes & Samuellson (2010) offers insight on this matter. They reported structural equation models for each sample (Norwegian/Swedish and English) separately and also reported an analysis of structural invariance across models. They found that while different patterns of significant predictors were identified for each language in the separate language models, the structural paths between the predictors and reading was the same across languages, and as such, a language universal model also provided a good fit.

This suggests that cross-linguistic differences are primarily quantitative: if readers in a transparent and opaque orthography are assessed in Grade 1, cross-linguistic differences will be evident as a result of the protracted rate of literacy development in opaque orthographies (see, for example, Seymour et al, 2003). However, the trajectory of literacy development is similar. This is supported by the study by Vaessen et al (2010) who found that, in a sample of children in grade 1 – 4, the contributions of various predictors shifted as a function of reading expertise and that this effect was the same across orthographies; the contribution of certain predictors (PA and letter-sound knowledge) were stronger predictors for a longer period in opaque orthographies.

The main source of controversy is the relative importance of PA and RAN to early literacy attainment in transparent and opaque orthographies. The relationship between each predictor and literacy attainment appears to be both language-dependent and skill-

dependent. Large scale studies by Ziegler et al (2010) and Vaessen et al (2010) found that while PA is a significant predictor of reading speed and accuracy in all languages studied, it was a stronger predictor in more opaque orthographies for a longer period of time. In contrast, RAN becomes a stronger predictor of reading attainment as reading expertise increases (Vaessen et al, 2010) though it has a similar relationship to reading across orthographies (Ziegler et al, 2010). Though other studies have found differing patterns of predictors for different languages, they indicate that the relevance of PA to reading increases in line with orthographic complexity (Mann & Wimmer, 2002; Landerl et al, 2018).

In sum, there is substantial evidence that the phonological and cognitive factors involved in literacy development at a given point in schooling (e.g. Grade 2) vary across languages. This is in keeping with the findings of studies (e.g. Seymour et al, 2003) which indicate that orthographic depth affects the time it takes to become literate in a language. This suggests that there is a quantitative difference in the cognitive factors involved in reading across languages, however there is less consensus in relation to the existence of qualitative differences. It is worth noting that these findings relate primarily to single word reading. This is likely to constrain the amount of cross-linguistic variation as additional sources of divergence between languages (e.g. morphological complexity) are not taken into account. Frost (2012) emphasises that any universal model of reading must take into account co-variation between all language components.

3.3.2 Predictive efficacy in dual-language educational contexts

It is evident, based on the studies examined in the previous section, that cross-linguistic differences exist in terms of the most effective predictors of literacy attainment at a given point in schooling. This section seeks to extend this review to investigate whether the most effective predictors of literacy attainment are the same or different in each of a bilingual's language and whether within-language or cross-linguistic predictors are more effective. The research base examined includes studies that investigated more than one predictor of word reading accuracy/fluency in dual language learners of alphabetic languages in primary school.

There is ample evidence that the pattern of cognitive and phonological skills that predict reading word accuracy and fluency differ in each of a bilingual's languages (Pasquarella et al, 2015; Jared et al, 2011; Swanson et al, 2008; Veii & Everatt, 2005; Lindsey et al, 2003; Gottardo & LaFrance, 2005) or differ in terms of the relative strength of predictors in each language (Comeau et al, 1999). Though such a study has not been conducted in Ireland, the strength of evidence in this regard suggests that it is worth investigating the predictors of

each of a bilinguals' language separately, rather than assuming that the same pattern will emerge in both.

The extent to which literacy skills are language-specific or language-universal within an individual is an issue of both theoretical and practical importance, given the assumption of positive transfer of skills in immersion education settings. A study (Pasquarella et al, 2015) which examined the degree of shared variance between L1 and L2 literacy attainment in both Spanish-English bilinguals and Chinese-English bilinguals indicated that it is both script- and task-dependent[30]. They found that there was a stronger relationship between Spanish and English literacy skills, reflecting the greater degree of similarity between the linguistic structures of Spanish and English, compared to Chinese and English. In both samples, there was a higher amount of shared variance[31] between the language pairs for word reading fluency than for word reading accuracy. This is interpreted as reflecting the greater amount of language-specific phonological, orthographic and morphological information required for accurate reading compared to the more language-universal determinants of reading fluency, including speed and automaticity of processing (Pasquarella et al, 2015).

The findings of previous studies which examine the relative strength of within-language and cross-linguistic predictors are mixed. A study of French-English balanced bilinguals found that within-language predictors were more effective than cross-linguistic predictors[32] (Gottardo & LaFrance, 2005). In keeping with this finding, a study of French-English bilinguals in French immersion education found that English predictors explain more variance in English word reading than in French word reading (Jared et al, 2011). Conversely, however, a study of Spanish-English bilinguals in dual-language education found that Spanish predictors explained more variance in English than in Spanish word reading (Lindsey, Manis & Bailey, 2003).

In sum, previous research into predictors of literacy attainment in bilinguals indicates that (i) the pattern of predictors in each of a bilingual's languages differ (ii) the extent to which the literacy skills are language-universal or language-specific depends on the degree of similarity between linguistic structures in each of a bilingual's languages and (iii) the

[30] Pasquarella and colleagues (2015) found that there was a weak relationship between Chinese and English word reading accuracy (WRA) in the Chinese-English bilinguals, but a moderate relationship between Spanish and English WRA in Spanish-English bilinguals. In relation to word reading fluency (WRF), there was a moderate relationship between Chinese and English WRF, and a strong relationship between Spanish and English WRF. (This was measured using structural coefficients in regression analysis. Structural coefficients are essentially Pearson correlation coefficients between the predictor and the dependent variable)

[31] A statistical measure which indicates how much two variables tend to vary together (i.e. the extent to which two variables overlap)

[32] An example of a within-language predictor is English PA predicting English word reading; an example of accross-linguististic predictor is French PA predicring English word reading.

balance of evidence suggests that within-language predictors are more effective than cross-linguistic predictors, though additional studies are necessary to refine our knowledge in this regard.

3.4 Chapter summary

To summarise, PA, RAN and VSTM are frequently investigated as predictors of literacy attainment across languages. In the present thesis, following Saiegh-Haddad (2019), a distinction is made between metalinguistic PA, and linguistic PA. The latter component is concerned with the ability to distinguish between phonemic contrasts, a particularly important skill for L2 spelling. In terms of their predictive efficacy, RAN is a particularly strong predictor of reading speed and fluency, while PA is a stronger predictor of decoding accuracy and spelling. VSTM is a relatively weak predictor of literacy attainment in comparison to both PA and RAN.

The extent to which the predictors are language-universal was examined. The findings of previous studies indicate that a common underlying proficiency support the development of dual-language literacy skills. In relation to cognitive abilities, previous research indicates that VSTM is a language-universal ability assuming a low threshold of language proficiency; in contrast, RAN appears to be a language-specific ability and highly influenced by frequency effects. The relationship between PA in each of a bilingual's languages varies from weak in some language pairs to strong in others. It was noted that, though previous studies include both metalinguistic and linguistic PA tasks, the distinction between these two task types is rarely acknowledged.

In relation to the predictors of literacy, different patterns of predictors exist across languages. This is due to the varying rate of literacy development across languages; it takes much longer to master foundational literacy skills in an opaque orthography such as English and in such orthographies, PA tends to remain a significant predictor for longer. With regard to children learning to read in two languages, there are typically differing patterns of predictors in each of their languages.

CHAPTER 4

DEVELOPMENT OF A DUAL-LANGUAGE TASK BATTERY

This chapter describes the development of the task battery used in the present study. The objective of the development process was to provide a battery of equivalent tasks in Irish and English to measure literacy attainment as well as constructs that predict literacy attainment, including phonemic awareness (PA), rapid automatised naming (RAN) and verbal short-term memory (VSTM). The approach taken in relation to task battery development was guided by the following criteria: the constructs chosen and the tasks used to measure them should (i) allow for the investigation of the research questions that guide this project (ii) predict literacy attainment in previously-studied populations (iii) be comparable to those used in other studies, in order to allow for cross-linguistic comparisons where relevant (iv) be appropriate, in terms of difficulty level, for the age groups included in this study and (v) be time-efficient, in order to avoid participant fatigue.

The simultaneous development of the tasks in Irish and English was guided from the outset by the International Test Commission Guidelines for Test Translation and Adaptation (Muñiz et al, 2013; Hambleton & Patsula, 1999). The process of task battery development (outlined in Figure 3) involved an initial analysis of previous studies in order to investigate which task types were used to measure PA, RAN and VSTM as well as literacy attainment. Based on this analysis and on the other selection criteria, task types were chosen and then pre-tested with a sample of the target population. The task battery was modified based on the findings of this pre-test, and the stimuli were refined. The second iteration of the task battery was subsequently pre-tested with a different sample of the target population before being finalised. These stages are detailed in the present chapter.

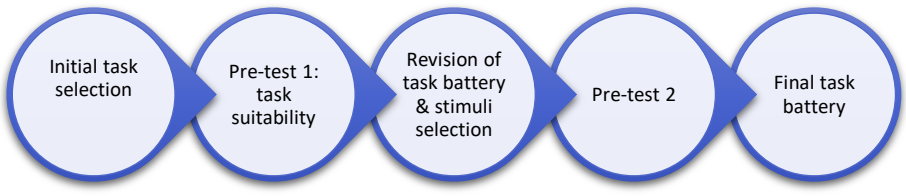

Figure 3 The process of task battery development in the present study

4.1 Initial task selection

Given the focus on PA, RAN and VSTM in the literature, each of these constructs was examined as possible predictors of Irish and English literacy attainment in the present study. A variety of tasks exist to measure each of these constructs: the tasks used in previous cross-linguistic studies are outlined in § 4.1.1 in order to provide context for the initial task choice in this study, which is described in § 4.1.2. Note that this does not represent the final selection of task types: additional tasks were introduced subsequent to the findings of Pre-Test 1 (outlined in § 4.2). The tasks included in the final iteration of the task battery are listed in § 4.3.

4.1.1 Tasks used in previous studies

There have been many studies done in relation to the predictors of literacy; those analysed here are a subset of those which are cross-linguistic in nature[33]. Table 4 illustrates the tasks used to measure PA, RAN, VSTM and literacy attainment, as well as any additional constructs which were investigated as predictors in any given study.

Phonemic awareness. Phoneme Deletion was the most frequently used PA task, and the only one used independently; all of the others were included as part of a composite measure. This task requires the participant to delete a phoneme from initial, medial or final position in a word. Other tasks used include a Phoneme Identity Judgement task (which requires the participant to identify which of two pseudowords begins with a target phoneme), Spoonerism task (which requires the participant to isolate and transpose the initial consonants of a pair of words), Syllable and Phoneme Blending tasks (which require the participant to synthesise a number of phonemes into a word), and Phoneme Isolation tasks (which require the participant to isolate a single phoneme from a word). Note that the vast majority of these tasks, with the exception of Phoneme Identity Judgement, tap the metalinguistic component of PA.

Rapid Automatised Naming . RAN tasks require the participant to name a series of items (objects, letters, digits or colours) presented on a page as quickly as possible. The majority of studies used a composite measure of RAN which includes more than one type of RAN task, though two used a single measure. The single study which does not use a

[33] The studies included in this methodological analysis are limited to a sample of those (i) published between the years 2000 – 2018, which (ii) investigate more than one predictor variable for literacy for (iii) kindergarten or elementary school children who were typically-developing or had reading difficulties in (iv) more than one alphabetic language. This review focuses on studies which met these characteristics by testing two separate language cohorts. Articles which described studies which have overlapping samples were excluded. While longitudinal data allows for the predictive ability of variables to be investigated in the most stringent manner, the number of such studies was small and so this was not a prerequisite for inclusion.

RAN task (Caravolas, Volín & Hulme, 2005) uses the WISC-III coding subtest which measures speed of processing and so taps a similar construct.

Verbal Short-Term Memory. The most frequently used measure of VSTM is a Forward Digit Span task, though Word Span and Phoneme/Syllable Span are also used in one study each. One study (Caravolas et al, 2005) does not specify whether Forward or Backward Digit Span tasks were used, or whether both were used in a composite measure. A number of studies included in this methodological analysis do not measure VSTM as a possible predictor of literacy, possibly due to the less robust evidence in relation to its predictive efficacy in comparison to both PA and RAN (see § 3.1.2).

Literacy attainment. Word and nonword reading speed, accuracy and fluency were frequently used as measures of literacy attainment. Spelling, on the other hand, was examined in just three studies.

Other constructs. Vocabulary was examined in a number of studies, as was Letter Sound or Letter Name Knowledge. An Orthographic Choice task was also used in a single study to measure orthographic awareness. In this task, participants view words that sound alike (e.g., *rain - rane*) and are asked to circle the one that is spelled correctly.

Table 4
Tasks used to measure literacy attainment and its predictors in previous cross-linguistic studies

Author	Task used to measure PA	Task used to measure RAN	Task used to measure VSTM	Other predictors investigated	Literacy attainment measure
Mann & Wimmer, 2002	Phoneme identity judgement Phoneme Deletion (composite)	RAN Colours	Forward Digit Span		Word and nonword reading speed Word and nonword reading accuracy
Patel et al, 2004	Phoneme Deletion	RAN objects and RAN colours	-	Vocabulary	Word reading accuracy Word reading speed Nonword reading accuracy Nonword reading speed
Caravolas et al, 2005	Phoneme Deletion Spoonerisms (composite)	-	Digit Span	WISC-III Coding subtest (measuring speed of processing)	Word reading speed Spelling
Georgiou et al, 2008	Phoneme Deletion	RAN colours RAN digits	Forward Digit Span	Orthographic choice	Word reading fluency Phonological decoding
Ziegler et al, 2010	Phoneme Deletion	RAN Objects	Forward Digit Span	Vocabulary	Word reading speed Word reading accuracy Decoding speed Decoding accuracy
Furnes & Samuellson, 2010	Syllable and Phoneme blending Syllable and Phoneme Deletion	RAN Digits RAN Letters	-	Vocabulary	Word reading fluency Phonological decoding Spelling
Vaessen et al, 2010	Phoneme Deletion	RAN Letters RAN Digits	Phoneme Forward Span task	Letter-sound knowledge (speeded)	Word reading fluency

		RAN Objects	Syllable Forward Span task		
Caravolas et al, 2012	Phoneme Isolation Phoneme Blending	RAN Colours RAN Objects	Forward Word Span	Letter name and sound knowledge	Word reading fluency & picture-word matching test Spelling
López-Escribano et al, 2018	Phoneme Deletion	RAN Letters RAN Objects	-	Vocabulary	Reading speed
Landerl et al, 2018	Phoneme Deletion	RAN Colours RAN Digits	-		Word and nonword reading fluency

4.1.2 Initial task selection in present study

The tasks initially selected to measure PA, RAN, VSTM and literacy attainment in the present study are described below, with later modifications laid out in § 4.3.

Phonemic awareness. The selection of PA tasks was largely guided by the second research question (outlined in §1.6), relating to the linguistic and metalinguistic components of PA. It was decided to use two tasks, one which allowed for an investigation of the linguistic component of PA (LPA), and one which focussed on the metalinguistic component of PA (MPA).

The tasks chosen were:

I. LPA: A (word-to-word) Phoneme Matching task was selected to measure LPA. This task requires the participant to indicate whether a pair of words begin with the same initial phoneme or different initial phonemes, allowing for the investigation of the ability to distinguish between phonemic contrasts in one language which do not exist in the other.

II. MPA: A Phoneme Deletion task was selected to measure MPA. As noted in § 4.1.1, this task is frequently used – allowing for comparability with other studies - and is an effective predictor of literacy attainment.

Rapid Automatised Naming. The choice of RAN task was primarily guided by the principle of maximising equivalence between the Irish and English version of the task. RAN Objects was chosen as it is more flexible in terms of the stimuli which can be included, contrasting with other tasks such as RAN Colours and RAN Digits which would necessitate using words which have different lengths of articulation in Irish and English. RAN Letters would not allow for a cross-language comparison, as children often use the same letter names in both English and Irish.

Verbal Short-Term Memory. Though VSTM is not as robust a predictor as PA and RAN, it was decided to include a span task in the present task battery as it is frequently used in other studies. Initially, an established task (WISC Digit Span task: Weshcler, 2003) was used to measure this construct at the pre-testing stage, however it was later replaced with an experimental Forward Word Span task (see Table 7).

Literacy attainment. A word reading task was used as a measure of literacy attainment in this study, given that it is typically used in other studies. The focus on literacy attainment at the word level (rather than at the sentence level) is perhaps influenced by definitions of dyslexia which describe difficulties at the word level (e.g. Vellutino, 2005).

A spelling task was later included following the first pre-test (detailed in § 4.2). A nonword reading and nonword spelling task were also developed, and were intended to be used in a second phase of data collection a year on from the first phase. This was not conducted due to school closures related to Covid-19.

4.1.3 Stimuli selection

The process of selecting stimuli for each task involved a preparatory phase in which possible sources of bias were listed and a short corpus of words in early literacy textbooks and readers was compiled in order to be able to estimate word familiarity. The most important guiding principle in the process of stimuli selection was that of equivalence between different language versions of the task; equivalence is necessary in order to draw comparisons between performance on the same task in two languages. It has been suggested that much cross-cultural research is "flawed to the point of being invalid" as a result of non-equivalence due to poor test adaptation (Hambleton et al, 2004, pp. 4).

The main threat to equivalence is unconscious bias. Van de Vivjer and colleagues (Van de Vivjer & Tanzer, 1997; He & Van de Vijver, 2012) identify three types of bias:

I. *Construct bias* occurs when the construct measured differs across cultural groups (e.g. the concept of intelligence).
II. *Method bias* relates broadly to a study's methodology, including sampling bias (e.g. socioeconomic status), instrument bias, response bias (e.g. acquiescence) or administration bias.
III. *Item bias* refers to bias at the item level of an assessment (e.g. poor translation of a test item).

In order to minimise its presence, possible sources of bias in the development of the present test battery were listed before embarking on the task design. For example, in the case of lexical stimuli, an effort was made to control for the number of phonemes/syllables in a stimulus, word frequency or familiarity, the concreteness of the word, and number of letters. There were various and sometimes conflicting requirements in terms of stimuli selection. For instance, on occasion the most appropriate stimuli in terms of phonemic composition were very low-frequency words. The stimuli selected for each task is outlined in § 4.3

Estimating word familiarity in Irish and English. As word familiarity was a likely source of bias between the two language versions of the task, a corpus of nouns and adjectives was compiled based on school textbooks and readers for Irish and English. For Irish, textbooks and readers from *Séideán Sí* (An Gúm, 2003) were used; for English,

Reading Zone (Folens, 2011) textbooks were used. These particular textbooks were chosen as they were found, in research conducted by Neasa Ní Chuaig (2016), to be the most widely used in Irish-medium schools. Stimuli for the age-specific tasks were selected from the relevant corpora.

4.2 Pre-testing

The initial iteration of the task battery was pre-tested with two separate samples of Gaelscoil pupils. Ethical approval was obtained from the Research Ethics Committee of the School of Linguistic, Communication and Speech Sciences (Appendix 1). Consent was obtained from parents/guardians of participants (Appendix 2) The purpose of the first pre-test was to gauge the difficulty level of the tasks for the age-groups in question, and to identify any issues with task instructions. A number of amendments – outlined in Table 7 - were then made to the task battery. A subsequent pre-test was then conducted, with a focus on the appropriateness of individual stimuli.

4.2.1 Pre-Test 1

The tasks selected and designed in the first iteration of the task battery were pre-tested in order to evaluate their suitability for use with the target population and to identify any unexpected issues in the implementation of tasks.

Method. A structured non-participant observation design was used in the pre-test. It was a controlled observation, designed to observe the groups' interaction with the tasks. The data collection tool used was designed specifically for the pre-test (see Appendix 3), and included questions relating to:

I. The difficulty level of each task for each group
II. The clarity and appropriateness of instructions and practice items
III. Behavioural observations relating to the participant's motivation to complete tasks
IV. Suggestions for improvements.

Participants. Participants all attended the same Gaelscoil located in north County Dublin. Pupils in Grade 1 (n = 6), Grade 2 (n = 12), Grade 3 (n = 6) and Grade 4[34] (n = 12) took part in the pre-test. Teachers were asked to choose a group of pupils which was mixed in terms of academic attainment.

[34] Originally, it was envisaged that there would be two points of data collection, one year apart. The tasks were tested with Grade 4 pupils as the Grade 3 pupils at Time Point 1 would by in Grade 4 at Time Point 2. The second point of data collection was not carried out due to Covid-19 restrictions.

Tasks. The tasks used in this pre-test, and the constructs they are intended to measure, are outlined in Table 5.

Table 5
Constructs examined as part of Pre-Test 1 and the tasks used to measure them

Construct	***Corresponding task***
Linguistic phonemic awareness	Phoneme Matching task
Metalinguistic phonemic awareness	Phoneme Deletion task
Rapid automatised naming	RAN Objects task
Verbal short-term memory	WISC Forward Digit Span task (Wechsler, 2003)
Literacy attainment	Word Reading and Non-Word Reading task

Procedure. The pre-test took place in June 2018, in a room used for resource teaching. All of the tasks were carried out in Irish and then in English within the same session due to time constraints. Each of the tasks were framed as a game in order to put the children at ease and increase their motivation to engage with the task. For example, for the phoneme deletion game, the children acted as "word detectives" and were given a miniature magnifying glass to put on their score cards each time they found a small word inside a bigger word (e.g. "up" within "cup"). Additional information on the games included in the final test battery is provided in § 4.4.1.

Prior to starting the task, I had a general conversation with the children on topics related to their everyday lives (the sports they took part in, TV programmes they liked, etc.) in order to develop a rapport with the children. Then, I told them the premise of the game and gave them an opportunity to ask questions. I administered each task and then evaluated each task individually with respect to questions pertaining to (i)-(iv) above.

Results and Discussion. Results pertaining to the difficulty level of tasks, the clarity of practice items and observations in relation to participants behaviour are outlined below. Table 6 indicates the difficulty level reported for each task.

Difficulty level. While the Phoneme Matching task had an appropriate difficulty level for Grade 1 participants, there was a relatively small amount of variation in the performance of Grade 2 participants. The Phoneme Deletion task was too difficult for Grade 1 pupils, but was appropriate for all other groups, though there was a large amount of variation in the performance of Grade 2 pupils. In Grade 4, pupils were very proficient at deleting initial phonemes but were still challenged by deleting a final phoneme or an initial phoneme from

a cluster[35].The RAN Objects task and the WISC Forward Digit Span task was at an appropriate level of difficulty for all groups. However, a source of bias was identified in the WISC Digit Span Task; there was a tendency for digit spans to be longer on the English version of tasks, compared to the Irish version. This may have been due to linguistic dominance in English, but it is also likely to have be affected by the longer articulation length of the numbers in Irish in comparison to English.

Table 6
Difficulty level of Iteration 1 of the task battery

	LPA: Phoneme Matching	**MPA: Phoneme Deletion**	**RAN Objects**	**VSTM: WISC Digit Span task**	**Literacy attainment: word and nonword reading**
Grade 1	Appropriate	Very difficult	Appropriate	Appropriate	Very difficult
Grade 2	Appropriate - Easy	Appropriate - Difficult	Appropriate	Appropriate	Appropriate - Difficult
Grade 3	-	Appropriate	Appropriate	Appropriate	Appropriate
Grade 4	-	Appropriate (initial clusters; final phonemes) Easy (initial phonemes)	Appropriate	Appropriate	Appropriate (nonwords in Irish) Easy (real words in Irish & English; nonwords in English)

The word reading task was unsuitable for the Grade 1 group as floor effects were evident. The task was deemed appropriate-to-difficult in the Grade 2 group, and there was a large amount of variation in terms of reading ability. There was some indication that, from Grade 3 onwards, reading speed may be more important than reading accuracy in terms of accounting for variance in reading attainment. It was evident that the real-word stimuli in Irish and English, as well as the nonword stimuli in English, were too easy for the Grade 4 pupils. Irish nonwords were notably more difficult than English nonwords for the Grade 3 and Grade 4 pupils, echoing results from Parsons and Lyddy's (2016) study with Irish-English bilinguals.

[35] From the perspective of abstract phonological representation, it is interesting to note that when asked to delete the first phoneme from the word *teach* (/tʲax/ "house") in Irish, most participants gave the answer /ax/, however one participant kept the offglide, answering /jax/.

Clarity and appropriateness of instructions and practice items. Participants understood the requirements of the task from the instructions and practice items provided.

Behavioural observations. Participants were motivated to complete the tasks and enjoyed the game element. There was one instance of a Grade 1 participant expressing boredom when another participant was providing answers. As the main study was carried out with individual participants rather than groups, this was not an issue.

Table 7
Amendments made to the task battery based on the findings of pre-tests

Construct	Initial task selected	Amendments based on Pre-test 1	Amendments based on pre-test 2
Linguistic phonemic awareness	Phoneme Matching task	**Modified** to include more difficult stimuli; will be administered to all age-groups	**Modified** to include different stimuli
Metalinguistic phonemic awareness	Phoneme Deletion task		**Modified** to include stimuli resistant to syllable-breaking (described further in § 4.2.2)
Rapid automatised naming	RAN Objects task		
Verbal short-term memory	WISC Forward Digit Span task (Wechsler, 2003)	**Replaced** with experimental Forward Word Span task which requires the participant to listen to and recall a list of objects. This change was made due to the difference in articulation length of Irish and English numbers which rendered the WISC Forward Digit Span task non-equivalent across this language pair. The objects chosen for the Forward Word Span task (described in § 4.3.4) have similar lengths of articulation in each language.	
Literacy attainment	Word Reading and Non-Word Reading task	**Redesigned** to include a timed element for Grade 3 pupils (participants have two minutes to read as many words as possible) **Addition** of a spelling task designed for Grade 3 pupils in order to broaden the concept of literacy attainment used in this study, as well as to provide insight into the challenges presented by each writing system. This motivated the development of Research Question 4.	
Productive vocabulary *(addition)*		**Addition** of a Productive Vocabulary task to provide an indication of the child's proficiency in Irish. The task – further described in § 4.3.5 – consists of 45 images of high frequency objects which the participant is required to name. Originally the task was administered in Irish and English; however, the English version of the task was subsequently discontinued due to ceiling effects.	

4.2.2 Pre-Test 2

The revised task battery was pre-tested with a smaller group of students in a different school, to ensure the suitability of the additional tasks, and of individual stimuli.

Method

A structured non-participant design was used in this second pre-test. The data collection tool, provided in Appendix 3, was designed specifically for the pre-test, and included questions relating to:

I. The difficulty level of the tasks which had not yet been pre-tested (Forward Word Span task and Productive Vocabulary task)

II. The appropriateness of the stimuli in each task

III. Behavioural observations relating to the participant's motivation to complete tasks, particularly the computerised versions of tasks.

Participants. Participants all attended the same Gaelscoil located in west County Dublin. Pupils in Grade 1 (n = 6) and Grade 2 (n = 6), took part in the second pre-test. Of the six participants in Grade 2, three completed the tasks as a group and three completed them individually. Teachers were asked to choose a group of pupils which was mixed in terms of academic attainment.

Tasks. The tasks included are listed in Table 8. The spelling task was not included as the cohort did not include Grade 3 or Grade 4 pupils.

Table 8
Constructs examined as part of Pre-test 2 and the tasks used to measure them

Construct	***Corresponding task***
Linguistic phonemic awareness	Phoneme Matching task
Metalinguistic phonemic awareness	Phoneme Deletion task
Rapid automatised naming	RAN Objects task
Verbal short-term memory	Forward Word Span task
Productive vocabulary	Productive Vocabulary task
Literacy attainment	Word and Non-Word Reading task (Grade 2)

Procedure. The pre-test took place in December 2018, in the library of the school. As in Pre-Test 1, all of the tasks were carried out in Irish and then English within

the same session for each group. I administered each task myself and then answered each of the questions on the data collection tool in relation to that task.

Results. All tasks, including the new tasks - the Forward Word Span task and Productive Vocabulary task - were appropriate in terms of difficulty level for the relevant age groups.

Task stimuli. There were minor difficulties with the task stimuli in certain tasks. In the Phoneme Deletion task, a number of stimuli were deemed inappropriate due to syllable-breaking. This affected stimuli which contained close vowels /i:/ and /u:/. Participants pronounced the typically monosyllabic word *súil* (‘*eye’*) for example, as a disyllabic word /su:.ɪl/. These stimuli were replaced with words containing vowels /a:/ and /o:/ which were resistant to such syllable-breaking.

Additionally, in the Phoneme Matching task, one of the stimuli sets which was intended to be a matching phoneme stimulus item (*beola* /bʲoːl̪ʸə/, *‘lips’*; *beacha* /bʲa.xʸə/, *‘bees’*) was consistently deemed to be a mismatched phoneme stimulus. On reflection, it was noted that one word in the pair has a strong offglide after the initial consonant and one does not. These stimuli were replaced.

Task design. Computer-based PA tasks worked effectively, however more frequent feedback was needed within the tasks to maintain participants’ attention.

4.3 Final task battery

The tasks included in the final task battery are illustrated schematically in Figure 4, and outlined below.

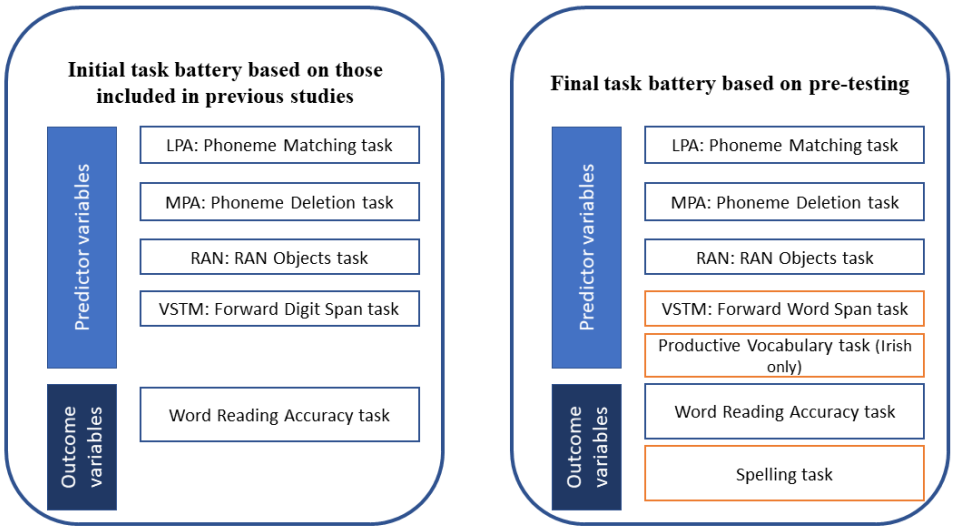

Figure 4 Tasks included in the final task battery based on pre-testing. Note: tasks which were amended or added based on pre-tests are outlined in orange.

4.3.1 Linguistic phonemic awareness: Phoneme Matching task

The Phoneme Matching task, chosen to measure LPA, requires the participant to indicate whether a pair of words start with the same phoneme or with different phonemes. This task was administered to all participants. It contains a total of 24 stimuli pairs in each language, of which 16 are consonant-initial stimuli and 8 are vowel-initial stimuli. The Irish and English version are matched for the number of syllables in each pair. An effort was made to include concrete nouns wherever possible, and the majority of the stimuli are found in the corpus based on schoolbooks and readers (described in § 4.1.3). Due to the difficulty in finding stimuli which would be familiar to children and which had the required initial phonemes, it was not possible to match each stimulus in Irish and English for the number of phonemes. None of the stimuli includes initial consonant clusters.

Stimuli. Stimuli were developed for each condition based on four consonant phonemes (or phoneme pairs, in Irish) and two vowel phonemes in each language. The conditions and the stimuli are outlined in Table 9 for Irish, and Table 10 for English. Disyllabic words were chosen, with the exception of a single pair in both the Irish and English condition (marked with an asterisk in Table 9 and Table 10).

Table 9
Stimuli included in the Irish Phoneme Matching task.
*Note: *Monosyllabic word pairs.*

Irish								
Consonants								
	Matching CV unit		Matching phoneme		Mismatching CV unit (palatalised-velarised contrasts)		Mismatching phoneme	
S	**/ʃʲi:/**	sióg	**/ʃʲ/**	seomra	**/ʃʲu:/**	siúcra	**/ʃʲ/**	siúlóid
	/ʃʲi:/	Síle	**/ʃʲ/**	siopaí	**/sʸu:/**	suas	**/mʸ/**	mála
B	**/bʸo:/**	bóthar	**/bʸ/**	boscaí	**/bʸo:/**	bóthar	**/bʸ/**	buachaill
	/bʸo:/	bóín	**/bʸ/**	bainne	**/bʲo:/**	beola	**/ɟ/**	geata
D	**/dʲi:/**	dísle	**/dʲ/**	dearg	**/dʲi:/**	dísle	**/dʸ/**	dochtúir
	/dʲi:/	dinnéar	**/dʲ/**	deifir	**/dʸi:/**	daoine	**/mʲ/**	milseán
C	**/kʸo:/**	cófra	**/kʸ/**	cácaí	**/kʸo:/**	cótaí	**/cʲ/**	citeal
	/kʸo:/	cótaí	**/kʸ/**	cosa	**/cʲo:/**	ceomhar	**/lʲ/**	leaba
Vowels								
	Short vowel match		Long vowel match		Vowel length mismatch		Vowel mismatch	
E	**/ɛ/**	eitleog	**/e:/**	éasca	**/ɛ/**	eitleán	**/e:/**	éinín
	/ɛ/	Eibhlín	**/e:/**	éadaí	**/e:/**	éadaí	**/u:/**	úlla
O	**/ʌ/**	ocras	**/o:/**	óg*	**/ʌ/**	ocras	**/ʌ/**	obair
	/ʌ/	eochair	**/o:/**	ól*	**/o:/**	óstan	**/ɪ/**	uisce

Table 10
Stimuli included in the English Phoneme Matching task.
*Note: *Monosyllabic word pairs.*

English								
Consonants								
	Matching CV unit		Matching phoneme		Mismatching CV unit		Mismatching phoneme	
R	**/ɹɪ/**	ring*	**/ɹ/**	river	**/ɹa/**	rabbit	**/w/**	water
	/ɹɪ/	wrist*	**/ɹ/**	robin	**/ka/**	candle	**/ɹ/**	writing
F	**/fɪ/**	finger	**/f/**	photo	**/fo:/**	photo	**/f/**	family
	/fɪ/	fishing	**/f/**	farmer	**/po:/**	postman	**/t/**	table
J	**/dʒe/**	jelly	**/dʒ/**	jewel	**/dʒʌ/**	jungle	**/dʒ/**	giraffe
	/dʒe/	gentle	**/dʒ/**	jacket	**/pʌ/**	puppy	**/g/**	garden
S	**/sʌ/**	sunny	**/s/**	circle	**/ʃʌ/**	sugar	**/s/**	sandal
	/sʌ/	supper	**/s/**	sailor	**/sʌ/**	summer	**/b/**	biscuit
Vowels								
	Short vowel match		Long vowel match		Mismatching vowels with same grapheme		Vowel mistmatch	
O	**/ɑ/**	otter	**/o:/**	open	**/ɑ/**	ostrich	**/o:/**	oval
	/ɑ/	ostrich	**/o:/**	over	**/o:/**	open	**/eɪ/**	acorn
A	**/a/**	apple	**/eɪ/**	apron	**/a/**	actor	**/a/**	apple
	/a/	actor	**/eɪ/**	angel	**/eɪ/**	angel	**/ɑ/**	otter

In addition to the investigation of LPA as a predictor of literacy attainment, the Phoneme Matching task is used to investigate two other research questions. These are:

RQ3 Which phonemic contrasts are typically identified inaccurately in Irish-English bilinguals?

RQ5a Is there evidence of orthographic effects or the use of orthographic strategies on responses to linguistic and/or metalinguistic phonemic awareness tasks?

In order to be able to investigate these research questions, it was necessary to include (i) a range of consonantal and vowel stimuli in each language and (ii) stimuli which are orthographically transparent and opaque. The decisions made in order to accommodate the investigation of these research questions are described below.

Language-specific stimuli (RQ3). The stimuli included in the final iteration of the Phoneme Matching task were carefully chosen in order to allow for the investigation of a language-specific component to PA. Of particular interest are the velarized-palatalised consonant contrasts in Irish, which may offer insight into the language-specific nature of

PA. As discussed in § 2.2.1, these consonantal contrasts are fundamental to both the phonology and orthography of Irish. However, the ability to distinguish between them reliably is typically not taught as part of PA or phonics training in Irish (Ní Chasaide et al, 2019).

Four of the mismatching consonantal stimuli involve velarized-palatalised consonantal contrasts. These are: *bóthar/beola* (/bˠ-bʲ/), *cótaí/ceomhar (*/kˠ-cʲ/), *siúcra/suas (*/ʃʲ-sˠ/) and *dísle/daoine* (/dʲ-dˠ/). These consonant phonemes were chosen to represent a range of velarised-palatalised consonant contrast, reflecting the fact that they involve not only differences in secondary articulation, as the term implies, but also sometimes differences in the primary articulation. For example, Ní Chasaide (1999), in her description of the Donegal dialect, points out that the contrast of /sˠ-ʃʲ/ and /cʲ-kˠ/ involve differences in both primary and secondary articulation, something that is reflected in the choice of symbols used to represent them[36]. The contrast /dʲ-dˠ/ also differs in both primary and secondary features as the palatalised consonant has a primary alveolopalatal articulation, while the velarised consonant is apico-dental with contact extending onto the alveolar ridge (Ní Chasaide, 1999). The contrast /bʲ-bˠ/ differs only in its secondary articulation, though it is noted that the velarised bilabial stop is additionally labialised (Ní Chasaide, 1999).

In the case of /ʃʲ-sˠ/, even if not identical, the contrast has a parallel in English which is typically taught in phonological awareness and phonics training of English. However, there are no phonemic contrasts in English which parallel the other palatalised-velarised contrasts mentioned above. For these reasons, it would be expected that the /ʃʲ-sˠ/ contrast would be the most readily available to L1 English speakers, while the contrasts of /cʲ-kˠ/ and /dʲ-dˠ/ would be less readily discerned, and the contrast /bʲ-bˠ/ being the least readily discerned. It is noted, though, that a perception study with native Irish- speaking adults found a slight advantage for the identification of labials in comparison to coronals (Ní Chiosáin & Padgett, 2012).

As mentioned in § 2.2.1, impressionistically, palatalised consonants are most striking in the context of a long back vowel, where there are major glides at the onset of the vowel. Similarly, velarisation is auditorily very striking in the context of a long front vowel, with a strong onglide onto the vowel (see Ní Chasaide, 1979; Quinn, 2020). In the present study, the stimuli for each pair of the velarised-palatalised consonantal contrasts (mismatched pairs) are followed by the same vowel, so that the vowel onglide differences are clearly represented. Strictly speaking, the contrast involves not only the initial consonant but also

[36] Note that in Ní Chasaide's account, the symbol /ɕ/ is used for the alveolopalatal consonant.

its impact on the following vowel, so one might argue that it is the CV unit which is minimally different, rather than simply the initial consonant.

For parity, four of the matching consonant pairs in the Irish version of the task also contain the same vowel. In order to maximise equivalence, this structure is mirrored in the English version of the task: eight of the consonant pairs (four matching, four mismatching) contain the same vowel, while eight do not. Note that this task is still referred to as a phonemic awareness task (rather than a syllabic awareness task) as it is the initial phoneme which is of interest.

Orthographic effects on phonemic awareness (Research Question 5). The effect of orthographic representations on performance in phonemic awareness tasks is investigated in this study. Stimuli which allow for the investigation of this research question are included in the English Phoneme Matching task. Within the four consonantal conditions, there are four different orthographic conditions. The stimuli in these conditions are outlined in Table 11 below for clarity, though they are also included in Table 10.

Table 11
Stimuli in each consonant condition in the English Phoneme Matching task

Matching phoneme condition			**Mismatching phoneme condition**			
	SLSP	**DLSP**		**DLDP**		**SLDP**
/s/	**s**unny-**s**upper	**c**ircle-**s**ailor	**/b/ - /t/**	**b**iscuit **t**able	**/ʃ/ - /s/**	**s**ugar-**s**unny
/ɹ/	**r**iver-**r**obin	**r**ing-**w**rist	**/ɹ/ - /k/**	**r**abbit-**c**andle	**/w/ - /ɹ/**	**w**ater-**w**riting
/dʒ/	**j**ewel-**j**acket	**j**elly-**g**entle	**/dʒ/ - /p/**	**j**ungle-**p**uppy	**/dʒ/ - /g/**	**g**iraffe-**g**arden
/f/	**f**inger-**f**ishing	**p**hoto-**f**armer	**/f/ - /s/**	**f**amily- **s**andal-	**/f/ - /p/**	**p**hoto-**p**ostman

Two of these conditions are matching conditions, in which the initial phoneme of each word in the pair matched. Of these matching conditions, one is orthographically transparent (same letter, same phoneme: SLSP) and one is orthographically opaque (different letter, same phoneme: DLSP). There were also two mismatching conditions: one orthographically transparent (different letter, different phoneme: DLDP) and one orthographically opaque (same letter, different phoneme: SLDP). This final condition (SLDP) mirrors the condition of the velarised-palatalised consonantal contrast in Irish (particularly for those who are not aware that the neighbouring vowel grapheme distinguished one from the other). A schematic illustration of the conditions is provided in Figure 5.

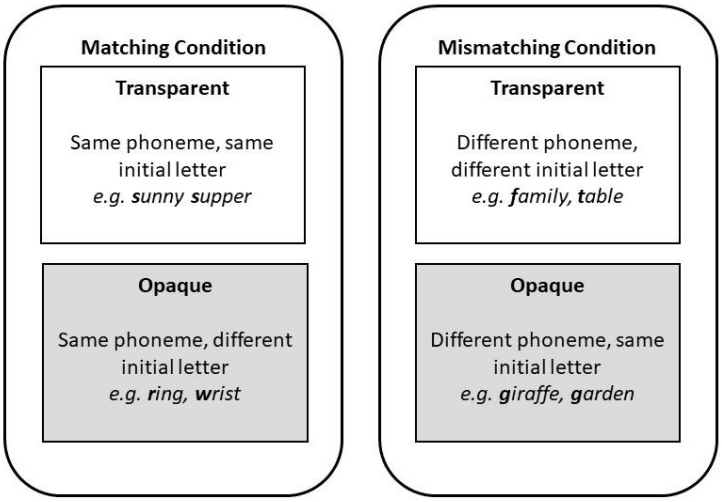

Figure 5 Orthographic conditions included in the Phoneme Matching task

Performance on the SLSP condition will be compared to performance on the DLSP condition to ascertain whether there is any significant difference between the ability to identifying matching phonemes when they start with the same letter, as opposed to when they start with different initial letters. Similarly, performance on the DLDP condition will be compared to performance on the SLDP condition, to examine whether there is a significant difference in the ability to identify mismatching phonemes when they start with different letters, as opposed to when they start with the same letter.

Note that there is no condition which matches the DLSP condition in the Irish version of the Phoneme Matching task. This was the case as there are typically not multiple consonant graphemes to represent the same phoneme in Irish[37], however it is a possible source of cross-linguistic bias within the task. Though this was not the case in the present study (see § 7.1.1), if there had been a statistically significant difference in performance on the SLSP condition and the DLSP condition in English, these stimuli would have been removed from participants' overall Phoneme Matching score along with four consonantal matching pairs from the Irish task.

4.3.2 Metalinguistic phonemic awareness: Phoneme Deletion task

The Phoneme Deletion task, chosen to measure MPA, requires the participant to delete a phoneme from initial or final position in a word. This task was administered to participants in Grade 2 and Grade 3. The maximum score on this task is twelve, though there is one

[37] Except for in the case of initial mutations. For example, a feminine noun which follows the definite article (e.g. the word <peil>, pronounced /pʲɛlʲ/; 'football') is lenited (to <pheil>, pronounced </fʲɛlʲ/). The phoneme /fˠ/ is typically represented by the grapheme <f> (adjacent to a broad vowel). Words which are mutated (lenited/eclipsed) were not used in the Phoneme Matching task as they only occur within a phrase, clause or sentence and not as a standalone word.

additional stimulus in the English version of the task (the rationale for which is described below). The stimuli included in the task, as well as the target phoneme of each, are reported in Table 12. There are five stimuli from which an initial single phoneme is deleted, four stimuli from which an initial phoneme is deleted from a consonant cluster, and three stimuli from which a final phoneme is deleted. The Irish and English versions are matched for the number of letters and phonemes where possible, though there are a small number of stimuli in which only the number of letters are matched. A possible source of bias in this task relates to whether the target word is a real word (e.g. *hair* without /h/ is *air*) or a nonword (e.g. *blanket* without /b/ is *lanket*). For this reason, the number of stimuli in which the target word is a real word is matched in the Irish and English version of the tasks. Finally, the stimuli were chosen based on the corpus described in § 4.1.3, in order to ensure a similar level of familiarity with the stimuli in each language.

Table 12
Stimuli included in the Phoneme Deletion task

Phoneme Deletion task: stimuli				
	Irish		**English**	
	Target phoneme	**Stimulus**	**Target phoneme**	**Stimulus**
Single initial phoneme	/gʲ/	gúna *'dress'*	/s/	sand
	/tʲ/	teach *'house'*	/w/	witch
	/nʲ/	nead *'nest'*	/b/	book
	/bʲ/	buí *'yellow'*	/t/	toy
	/ʃʲ/	sí *'her'*	/m/	me
Initial phoneme from cluster	/bʲ/	bláth *'flower'*	/k/	clock
	/kʲ/	crann *'trees'*	/t/	troll
	/sʲ/	spéir *'sky'*	/s/	snake
	/bʲ/	bróg *'shoe'*	/f/	frog
Final phoneme			*/b/*	*box**
	/nʲ/	leon *'lion'*	/l/	loaf
	/nʲ/	slán *'bye'*	/f/	food
	/k/	cearc *'hen'*	/ɹ/	rocks

Orthographic effects on phonemic awareness (Research Question 5a). In addition to the investigation of MPA as a predictor of literacy attainment, the Phoneme Deletion task is used to investigate an additional research question, stated below:

RQ5a Is there evidence of orthographic effects or the use of orthographic strategies on responses to linguistic and/or metalinguistic phonemic awareness tasks?

In order to investigate this research question, the English Phoneme Deletion task includes one additional stimulus which is not included in the general analysis of this task. The additional stimulus *box* /bɔks/ is included due to its biphonemic grapheme <x> (following Castles et al, 2003) and will be compared with performance on the stimulus *rocks* /ɹɔks/, both of which require the deletion of word final /s/.

4.3.3. Rapid Automatised Naming (Objects) task

To complete a RAN Objects task, participants are required to name the objects they see on a page as quickly as possible. This task was administered to all participants. The stimulus for this task included seven rows of five images on a single A4 page (a sample of which is provided in Figure 6). These five images are repeated in a random order in each of the rows. The same images are included in the Irish and English versions of the task.

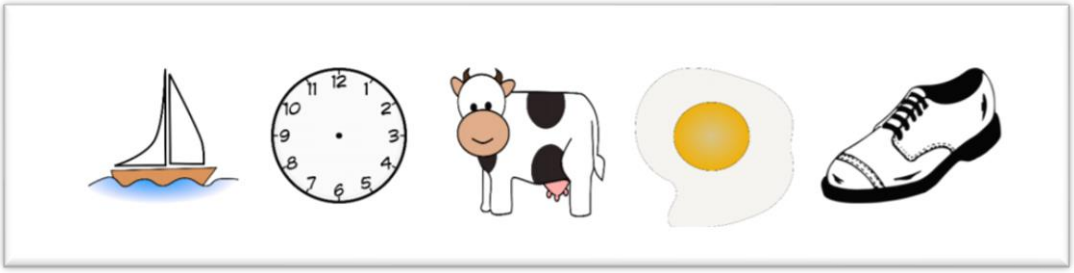

Figure 6 Visual stimuli included in the Rapid Automatised Naming task

These objects were chosen in order to maximise the equivalence of the Irish and English versions of the task, in terms of both familiarity and articulation length. Images chosen were semantically unambiguous in order to ensure that each participant used the same word to describe the picture. The names of these objects in Irish and English are provided in Table 13.

Table 13
Lexical items corresponding to visual stimuli included in the RAN Objects task

RAN Objects task	
Irish	**English**
bád	boat
clog	clock
bó	cow
ubh	egg
bróg	shoe

4.3.4 Verbal short-term memory: Forward Word Span task

A Forward Word Span task, chosen to measure VSTM, requires the participant to listen to and recall a list of words. This task was administered to all participants. The task begins with a list of two words and increases by one word each time the participant recalls the list correctly, up to a maximum of eight words. Note that it is the same stimuli repeated in the same order in each list, with one novel word added each time. In order to maximise the level of equivalence between the Irish and English versions of the tasks, an effort was made to match the articulation length of stimuli, and each version is matching for number of syllables and phonemes, syllable type (open/closed), and number of consonant clusters. The stimuli chosen – reported in Table 14 are easily-visualised concrete nouns, chosen based on their inclusion in age-appropriate schoolbooks.

Table 14
Stimuli included in the Forward Word Span task

Forward Word Span task: stimuli	
Irish	**English**
úll *'apple'*	egg
bád *'boat'*	ball
bus *'bus'*	bus
muc *'pig'*	hat
súil *'eye'*	boot
trá *'beach'*	sky
lón *'lunch'*	goat
cos *'foot'*	pig

4.3.5 Productive Vocabulary task

For this task, children are shown five images of objects from nine different categories (a total of 45 images) and required to name them. This task was administered to all

participants. Initially it was administered in both Irish and English. However, ceiling effects were evident in the scores of Grade 3 participants (who were the first group to be administered the tasks) and so the English version was discontinued and the task was only administered in Irish thereafter. Within each category, the words vary in terms of their frequency. The words chosen were easily-visualised concrete nouns or adjectives. The stimuli included in the task are outlined in Table 15 below. Note that any synonyms or dialectal variants were also accepted (e.g. *madadh* instead of *madra, araid* instead of *bosca bruscair,* etc.).

Table 15
Lexical items corresponding to visual stimuli included in the Productive Vocabulary task

Productive vocabulary task: stimuli		
Category	Target words: Irish	Target words: English
Animals:	madra, muc, capall, coinín, féileacán	dog; pig; horse; bunny; butterfly
Vehicles:	carr, bád, rothar, eitleán, tarracóir	car; boat; bike; plane; tractor
Toys	liathróid, leabhar, bábóg, peann luaidhe, sleamhnán	ball; book; doll; pencil; slide
Food and drink	bainne, úll, uachtar reoite, sceallóga, pónairí	milk; apple; ice-cream; chips; beans
Clothing:	cóta, stocaí, gúna, bríste, lámhainní	coat; socks; dress; trousers; gloves
Body parts:	súile, lámh, cluas, rúitín, méar	eyes; hand; ear; ankle; finger
Household:	solas, scuab, bosca bruscair, doirteal, cuisneoir	light; brush; bin; sink; fridge
Furniture:	doras, leaba, staighre, folcadán, tolg	door; bed; stairs; bath; sofa
Outdoors/nature	crann, bláth, scamall, gealach, cipín	tree; flower; cloud; moon; stick

4.3.6 Word Reading task

For the Word Reading task, participants were required to read a list of words. The task was untimed for Grade 2 participants, while the Grade 3 participants had two minutes to read as many words as possible. The list of words was chosen based on the corpus described in § 4.1.3 and increased in difficulty level (as measured by number of letters and complexity

of grapheme-phoneme rules). The list included 20 words for Grade 2 students and 40 for Grade 3 students. The Grade 3 Irish and English version were matched for number of letters and number of syllables. Each contained six 3-letter words, eight 4-letter words, thirteen 5-letter words, six 6-letter words, three 7-letter words three, 8-letter words and one 9-letter word. The words were chosen to reflect a wide range of syllable structures and letter-to-sound rules. The full word lists for Grade 2 and Grade 3 are included in Appendix 5.

As previously mentioned, a Nonword Reading task was also developed and pre-tested. It was intended to be used only in the second data collection point, which was not carried out due to Covid-19 restrictions.

4.3.7 Spelling task

For the spelling task, participants were required to spell eight words in untimed conditions. This task was administered to Grade 3 participants only. The words were chosen to reflect a range of syllables and grapheme-phoneme rules in each language. The Irish and English versions of this task are matched for the number of letters, number of syllables and number of consonant clusters. All except one stimulus are also matched for the number of phonemes. All of the stimuli chosen are concrete nouns which are found in the corpus described in § 4.1.3. These are provided in Table 16.

Table 16
Stimuli included in the spelling task

Spelling task: stimuli			
Irish		**English**	
rós	ɾʸoːsʸ	red	ɹɛd
trá	tʸɾʸɑː	arm	ɑːɹm
cás	kʸɑːsʸ	tap	tap
sásta	sʸɑːsʸtʸə	party	pɑɹtiː
súil	sʸuːlʲ	boat	boːt
fear	fʲaɾʸ	rope	roːp
carr	kʸɑːɾʸ	mess	mɛs
dubh	dʸuvʸ	sink	sɪŋk

4.4 Task format

Tasks which required aural prompts were carried out on a computer to allow for native speaker productions in both languages and to ensure consistency for each participant. A female native speaker of Irish, whose parents are also native Irish speakers, was recorded to this end in the semi-anechoic chamber of the Phonetics and Speech Laboratory (Trinity

College Dublin). All of the Irish phonemic contrasts investigated were present in her speech. A female native speaker of English was also recorded at the Phonetics and Speech Laboratory and all of the necessary phonemic contrasts were evident in her speech.

4.4.1 Computer-based tasks.

The engagement and feedback from children in the pre-tests informed the design of the tasks in game form. The computer-based tasks are all presented as simple games in which the participant is introduced to a character with an obstacle to overcome. For the Phoneme Matching task, the participant is asked to help a penguin learn Irish or English by telling the penguin when the words started with the same sound or with different sounds. In the Phoneme Deletion task, the participant is asked to help a fox find the magic word which was hidden within another word (pictured in Figure 7 below). For the Forward Word Span task, the child has to repeat what the parrot says to help him/her get to the top of a tree. In the Productive Vocabulary task, the participant has to teach an alien who had landed on earth the name of objects in different settings. Finally, in the Spelling task the participant is the teacher and is asked by students to spell the words with a whiteboard and marker. I designed these simple games using Microsoft PowerPoint.

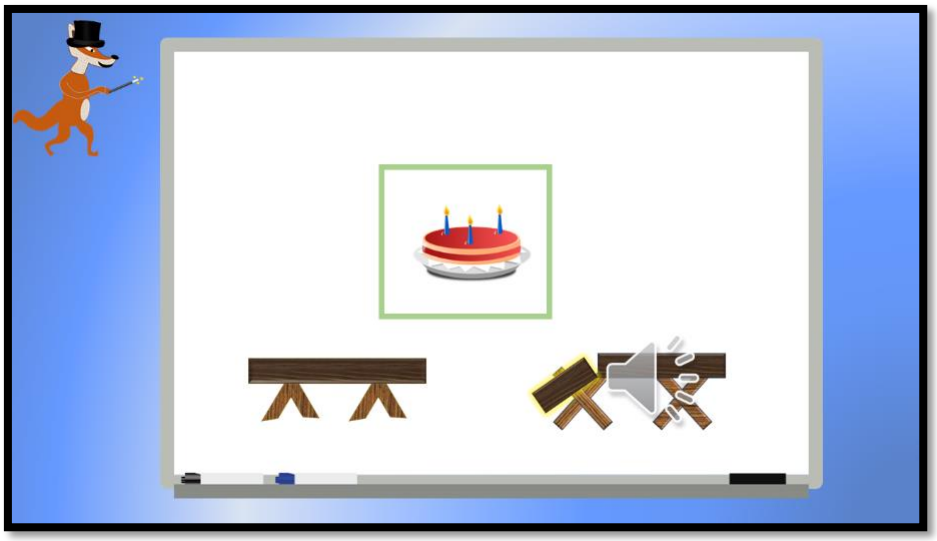

Figure 7 Image of a practice item in the Phoneme Deletion task. In this case, the participant was asked to delete the initial phoneme from the word cáca ('cake' /kʸaːkʸə/). The break in the block of wood was used to reinforce that the phoneme should be deleted from the start of the word (practice items for final phoneme deletion showed the wood breaking from the end of the block of wood).

4.4.2 Practice items

The majority of tasks included practice items to ensure that the participant understood the requirements of the task and the response format. For the Phoneme Deletion task, the practice items were used to ensure that participants understood that they were required to make a judgement on the initial phoneme in each word, rather than the initial grapheme. For tasks with more than one condition, practice items were included for each condition

(e.g. initial single phoneme, initial cluster and final phoneme in the Phoneme Deletion task). Further information on this is provided in § 5.6.

4.4.3 Feedback

Generic positive feedback was provided where possible during tasks in order to encourage and motivate participants. This feedback was very simple, consisting of a character smiling and a congratulatory sound, as well as an increase in the progress bar. An example of feedback in the task which examined productive vocabulary is provided Figure 8.

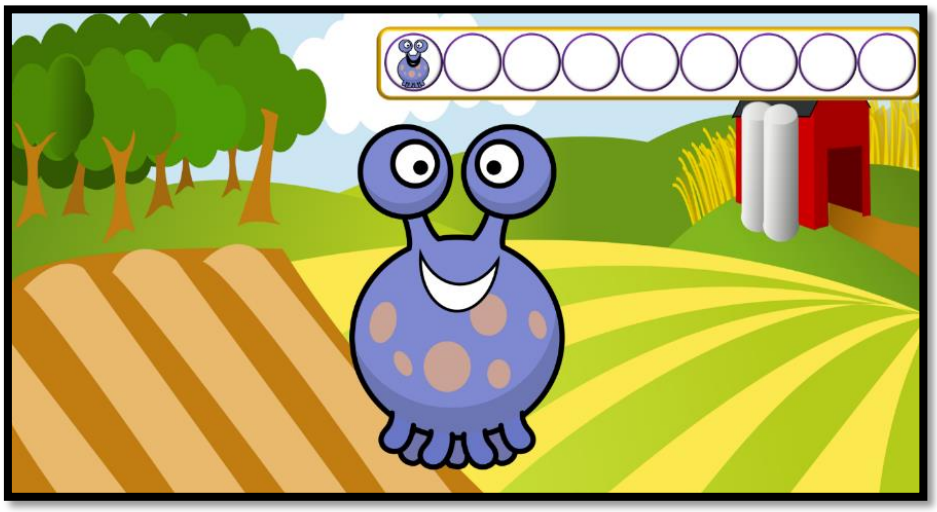

Figure 8 Example of feedback provided to participants (which included the character smiling, a congratulatory sound and an increase in the progress bar)

The format of each task as well as the positive feedback provided in each task are summarised in Table 17.

Table 17
Format and feedback details of each task

Task	Format	Positive Feedback
Phoneme Matching	Computer	In the middle of the task (after 12 pairs of stimuli) and at the end of the task.
Phoneme Deletion	Computer	Three times – once after the completion of each level.
RAN Objects	Paper	Provided by researcher at the end of task
Forward Word Span	Computer	After every correct span and at the end of the task
Productive Vocabulary	Computer	After every five objects
Word Reading	Paper	Provided by the researcher at the end of task
Spelling	Computer /Whiteboard	Provided by the researcher at the end of task

4.5 Limitations of the task battery

The main limitation to the process of task battery development is that the pre-tests were carried out with pupils in Gaelscoileanna but not with those in Gaeltacht schools. To ameliorate the impact of this, the stimuli from each of the tasks was analysed by a native speaker of Irish prior to the finalisation of the task battery.

Though a broad range of tasks are included in the task battery, the number of items per task was relatively low. It would be desirable, for example, to include repetitions of each of the stimuli in the Phoneme Matching task, or to include a broader range of stimuli. This was not done due to the time constraints of the study as well as the attention limits of younger children, however, it is an area in which this study could be extended.

In relation to the Forward Word Span task used to measure VSTM, there was a semantic relationship between two of the words in each language version of the task (*bád – bus* in Irish and *pig – goat* in English). Words with semantic associations are typically recalled more easily than those without (Savill et al, 2017). The inclusion of these semantically-similar words was an oversight, though it occurs in both language versions of the task.

4.6 Chapter summary

This chapter described the development of the task battery used in the present study. Experimental tasks in Irish and English were designed to have a high level of equivalence and to investigate the study's research questions. These tasks were then refined based on the findings of two small-scale pre-tests using a structured non-participant design. Discussion in this chapter has been limited to details pertaining to stimuli, format, practice items and feedback. The reliability and validity of the tasks are detailed in Chapter 5.

CHAPTER 5

METHODOLOGY

The study reported in this thesis is cross-sectional in nature. The methodological decisions made during the planning, implementation and analysis phases of the study are reported in this chapter. A detailed description of the sample of the study – which included children from Gaeltacht schools and Gaelscoileanna – is provided. The self-reported language background of each of these groups indicates that their experience with Irish and English is quite distinct. The data collection phase of this study took place over a five-month period in six different schools; the procedures used to collect data, as well as the methods used to analyse it are outlined.

5.1 Research Questions

The research questions investigated in the present study are stated below. Note that a more detailed rationale for the investigation of each of these questions is provided in § 1.6.

RQ1 Do scores for Irish-English bilinguals support the assertion that phonological and cognitive abilities (phonemic awareness, rapid automatised naming, verbal short-term memory) and literacy skills are language-universal?

RQ2 To what extent can metalinguistic phonemic awareness and linguistic phonemic awareness be considered the same construct (i) within languages and (ii) across languages?

RQ3 Which phonemic contrasts are typically identified inaccurately in Irish-English bilinguals?

RQ4 Are phonemic awareness errors reflected in the spelling errors made in Irish and English?

RQ5a Is there evidence of orthographic effects or the use of orthographic strategies on responses to linguistic and/or metalinguistic phonemic awareness tasks?

RQ5b If so, is there a relationship between the use of orthographic strategies and literacy attainment?

RQ6a How well do scores on the predictor tasks predict word reading and spelling attainment in GS and GT groups in Irish and English?

RQ6b What are the strongest predictors of word reading and spelling attainment in Irish and English in GT and GS groups?

5.2 Study Design

A cross-sectional study design was employed to investigate the research questions posed. In cross-sectional studies, participants are chosen based on inclusion and exclusion criteria set for the study (Setia, 2016). This is satisfactory in the investigation of the majority of the research questions. However, the lack of longitudinal data is a limitation to the investigation of RQ6, as the independent variables cannot be proven to be longitudinal predictors of later literacy attainment. As such, it is the concurrent criterion validity of the constructs, rather than their predictive criterion validity, which is investigated. However, these constructs have been found to be longitudinal predictors of literacy attainment in other studies (described in Chapter 3) and tasks which measure them are included in literacy screeners (e.g. Wagner et al, 1999). As mentioned in Chapter 3, there is some controversy with regard to the directionality of the relationship between certain predictor variables and literacy attainment. It is the strength of the relationship, rather than the direction of the relationship which is directly tested in this study.

5.2.1 Independent and dependent variables

In this study, a number of tasks designed to measure phonological constructs (LPA, MPA), cognitive constructs (RAN, VSTM), as well as tasks designed to measure literacy attainment (Word Reading accuracy and Spelling) were administered to participants at a single point in time. The variables and their corresponding task scores are outlined in Table 18.

Table 18
Dependent and independent variables examined in the present study and the tasks used to measure them

Type of variable	Variable name	Corresponding scores
Independent variable	Linguistic phonemic awareness (LPA)	Phoneme Matching
Independent variable (Grade 2 and 3 only)	Metalinguistic phonemic awareness (MPA)	Phoneme Deletion
Independent variable	Rapid automatised naming (RAN)	Rapid Automatised Naming (RAN Objects)
Independent variable	Verbal short-term memory (VSTM)	Forward Word Span
Independent variable	Irish vocabulary	Productive Vocabulary

Independent variable[38] (Grade 1 only)	Letter knowledge	Letter Naming
Dependent variable (Grade 2 and 3 only)	Word reading accuracy	Word Reading
Dependent variables (Grade 3 only)	Spelling	Spelling

5.2.2. Confounding, mediating and moderating variables

There are a number of additional variables which could affect the relationship between the independent and dependent variables listed above. These variables can be categorised as mediating, moderating or confounding variables. MacKinnon (2011) outlines the distinction between these categories of variable.

I. Mediating variables *explain a causal effect* between an independent variable X and a dependent variable Y (for example, if a study shows that countries in which English-language shows are subtitled rather than dubbed have a higher English-language proficiency, the mediating variable would be exposure to the language).

II. Moderating variables *affect the strength of the relationship* between the independent variable X and dependent variable Y, but do not entail or explain a causal effect (for example, if a study aims to increase muscle mass using a high-protein diet, biological sex could be a moderating variable).

III. Confounding variable *correlates with both the independent variable X and dependent variable Y* (for example, in a study which investigates the relationship between parents' language input and their childrens' vocabulary, socioeconomic status could be a confounding variable).

There were a number of additional variables which needed to be accounted for in this study. Potential moderating variables include (i) age and (ii) sex. Potential confounding variables include (i) early childhood education (ii) language of early childhood education (iii) parents/guardians' native language (iv) frequency of parental communication in Irish and English in the home and (v) literacy instruction method. This data was gleaned primarily from the questionnaires which participants' parents/guardians or guardians were required

[38]As two time points of data collection were originally planned, letter knowledge was intended to be used as an independent variable/predictor of literacy attainment (Grade 1 letter naming as a predictor of Grade 2 literacy attainment).

to fill out. All schools reported a mixed methods approach to literacy instruction, including phonics and sight word training in both Irish and English.

5.2.3 Ethical Approval

This research project was approved by the Research Ethics Committee of the School of Linguistic, Speech and Communication Sciences, Trinity College Dublin (Appendix 1).

5.3 Sampling

Nonprobability sampling was used in this study. In contrast to probability (random) sampling, each member of the population did not have the same probability of being included in the study. This would have entailed choosing participants at random in any eligible school in the country, which was not feasible due to the practical constraints of the time and cost associated with travel. The most significant limitation of nonprobability sampling is that the research results may not be generalisable to the broader population (Beins, 2018). The multi-stage sampling method used in this study is described in § 5.3.1 and § 5.3.2 below.

5.3.1 School Recruitment

A sampling frame for schools was developed, which defined the target populations (Ross, 1978). The sampling frame includes the following stratification variables:

i. school type: Gaelscoileanna (GS) and Gaeltacht schoors (GT);

ii. school size: schools with more than 100 pupils registered;

iii. school location

    a. Gaeltacht schools: schools within a 20-kilometre section of a single Gaeltacht region were recruited. The areas included were all Category A electoral districts (areas in which more than 67% of the total population are daily Irish speakers, and which exhibit stable levels of Irish use; Ó Giollagáin et al, 2007) in order to maximise the number of native speakers included.

    b. Gaelscoileanna: Schools within an (approximately) 20-kilometre section of Dublin city centre were recruited.

In order to establish which schools met these criteria, a list of all of the Gaelscoileanna and Gaeltacht schools in Ireland was requested from the organisation *Gaeloideachas.*, and a list was drawn up. A total of fourteen Gaelscoileanna and four Gaeltacht schools were

identified. Each principal was sent a letter and information sheet in Irish (see Appendix 6). The first four Gaelscoileanna (a total of five classes) who responded were included in the study. Two other schools subsequently responded; however it was not feasible to include any more schools in the study. One of these two schools took part in the second round of pre-testing. Two Gaeltacht schools responded and both were included in the study.

All schools are mixed-sex schools with similar numbers of male and female students, and all schools introduce Irish reading first and then English reading (after Easter in Grade 2 or at the beginning of Grade 3). The socioeconomic status of the schools' catchment areas is varied. According to the Pobal HP deprivation index[39], two of the participating Gaelscoileanna are situated in an area defined as "affluent", one is situated in an area defined as "disadvantaged" and one is in an area which has a mixture of "marginally above average", "marginally below average" and "disadvantaged" areas within the catchment area. One of the Gaeltacht schools is in an area which is "marginally above average" and one has a mixture of areas which are "marginally below average" and "disadvantaged" within its catchment area. The latter Gaeltacht school is the only participating school with DEIS status.

5.3.2 Participant Recruitment

When schools elected to take part, they were sent an envelope for each of the children in the participating classes (Grade 1, Grade 2 and Grade 3) which contained a letter, participant information leaflet, consent form and background questionnaire in Irish (an English version was also provided for each child in Gaelscoileanna; see Appendix 7 for all documents). Teachers of each class were asked to distribute the forms to parents/guardians of the children. In each case, the parents/guardians were given a period of two weeks to make a decision and send the consent form and questionnaire back. Respondents were required to provide information for one parent/guardian (referred to as Parent/Guardian A hereafter), and had the option of providing information in relation to an additional parent/guardian if relevant (Parent/Guardian B hereafter).

The background questionnaire contained questions relating to:

iv. the participant's pre-school education

v. the parents/guardians' native language

[39] This index is based on 2016 Census data which combines data on 10 key indicators of deprivation including education levels and emloyment levels. Each area is rated on an eight-point scale: extremely disadvantaged; very disadvantaged; disadvantaged; marginally below average; marginally above average; affluent; very affluent; extremely affluent. An interactive map is available at https://www.rte.ie/deprivation/

vi. the parents/guardians' language of schooling

vii. the frequency with which each parent/guardian communicated with their child in Irish, English and/or another language

viii. the presence of learning or behavioural differences in the child

5.3.3 Response rate

Table 19 below shows the response rate for children in participating Gaelscoileanna and Table 20 shows the response rate for those in participating Gaeltacht schools; the average response rate for Gaelscoileanna was 73%, while the average response rate of the Gaeltacht schools was 42%.

Table 19
Response rate of participants in Gaelscoileanna

	Grade 1	Grade 2	Grade 3	Total
GS 1	68%	73%	73%	71%
GS 2	85%	76%	50%	70%
GS 3	70%	83%	58%	70%
GS 4	68%	72%	80%	75%
Total	73%	76%	65%	73%

Table 20
Response rate of participants in Gaeltacht schools

	Grade 1	Grade 2	Grade 3	Total
GT 1	56%	50%	18%	41%
GT 2	31%	36%	62%	43%
Total	44%	43%	40%	42%

5.3.4 Inclusion and exclusion criteria

The inclusion criteria for the study were that (a) the child attended a Gaelscoil or Gaeltacht school, (b) the child was in Grade 1, Grade 2 or Grade 3 and (c) the child did not have a hearing impairment or any severe learning or behavioural difference which would affect

their ability to carry out a spoken language task or literacy task. Parents were required to disclose this information in the initial questionnaire.

While some previous studies have included IQ as an exclusion criterium, this was not the case in this study. Including an IQ threshold as an exclusion criterium for a study provides a sample that is a less accurate representation of the population (Mackenzie & Wonders, 2016). Given that this project has the practical objective of providing data towards the development of a literacy screening test, it should maximally reflect the population who would be undergoing a screening test.

5.3.5 Potential participants not included in final analysis

The total number of responses was 372 (116 Grade 1, 126 Grade 2; 131 Grade 3). Of this total, 27 are not included in the final analysis; the breakdown of those not included is provided in Table 21 below. Nine children were absent in the time allotted for their class. Nine children did not complete the tasks. Of these nine children, there were some cases in which the child indicated that they did not wish to do the tasks, and some in which the child did not carry out a task in the way intended, and as their data was then not comparable to other participants, it was not included in the final analysis. Due to time constraints within a given school or class, I was unable to carry out the tasks with nine children. This left 345 children in the final analysis (105 Grade 1, 115 Grade 2, 125 Grade 3)

Table 21
Potential participants that were not included in the final analysis

	Grade 1	Grade 2	Grade 3	Total
Absence	2	3	4	9
Uncompleted tasks	4	4	1	9
Time constraints	5	4	0	9
Total	11	11	5	27

The demographic information provided below relates only to the 345 participants included in the final analysis.

5.4 Participants

A total of 345 children participated in the study. Of these, 105 were in Grade 1, 115 were in Grade 2 and 125 were in Grade 3. One Grade 3 participant completed the tasks in Irish, but not in English (due to absence from school), and as such this participant's scores are

included in the analyses pertaining to Irish language tasks only. Information relating to the age of participants, the language of their pre-school education and their exposure to Irish and English at home is provided below.

The Grade 1 group consisted of a total of 83 participants (44 female, 39 male) and 22 participants in Gaeltacht schools (8 female, 14 male). The Grade 2 group consisted of 94 pupils in Gaelscoileanna (52 Female, 42 Male) and 21 pupils in Gaeltacht schools (10 female, 11 male). The Grade 3 group consisted of 105 pupils in Gaelscoileanna (61 Female, 44 Male) and 20 pupils in Gaeltacht schools (8 Females, 12 Male).

Table 22 illustrated the mean age (in months) of participants in Gaelscoileanna and Gaeltacht schools, along with the standard deviation (SD) from the mean.

Table 22
Mean age (in months) of participants in each grade

	GS	**GT**
Grade 1	63 (SD: 4.0)	63 (SD: 4.8)
Grade 2	75 (SD: 3.6)	75 (SD: 3.1)
Grade 3	86 (SD: 3.9)	87 (SD: 4.4)

In Grade 1, The mean age for both groups was 63 months (5 years and 3 months) on January 1st 2019. There was a similar amount of variation in terms of age within the two groups: in the GS group the youngest child was 56 months (4 years old and 8 months) and the oldest was 72 months (6 years). In the GT group, the youngest child was 55 months (4 years and 7 months) and the oldest was 72 months (6 years).

In Grade 2, the mean age for both groups was 75 months (6 years and 3 months) on January 1st 2019. There was a similar amount of variation in terms of age within the two groups: in the GS group the youngest child was 67 months (5 years and 7 months) and the oldest was 82 months (6 years and 10 months). In the GT group, the youngest child was 70 months (5 years and 10 months) and the oldest was 82 months (6 years and 10 months).

In Grade 3, the mean age for the GS group was 86 months (7 years and 2 months) and the mean for the GT group was 87 months (7 years and 3 months). There was some variation in terms of age; In the GS group the youngest child was 78 months (6 years and 6 months) and the oldest was 94 months (7 years and 10 months). In the GT group, the youngest child was 80 months (6 years and 8 months) and the oldest was 94 months (7 years and 10 months).

5.5 Participants' language background

Information pertaining to various aspects of participants' language background is provided in this section, including the language of their pre-school education, parents' native language and language input in the home.

5.5.1 Language of pre-school education

All of the participants had attended some form of pre-school education. Pre-school education is very accessible in Ireland due to the free pre-school years introduced as part of the Early Childhood Education and Care (ECCE) programme. One free year of pre-school education was introduced in 2010, and this was increased to two free years in 2018 (Government of Ireland, 2019).

The proportion of participants who attended pre-school education where the language of instruction was Irish, English or another language is presented in Figure 9 (Gaeltacht participants) and Figure 10 (Gaelscoil participants), and described below.

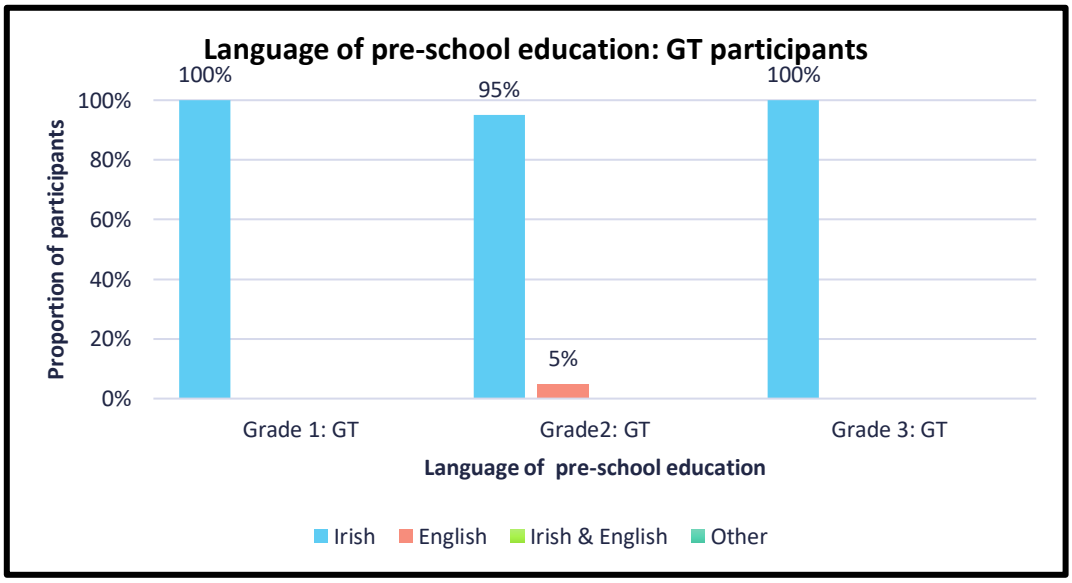

Figure 9 Gaeltacht participants: language of pre-school education as reported by parents/guardians

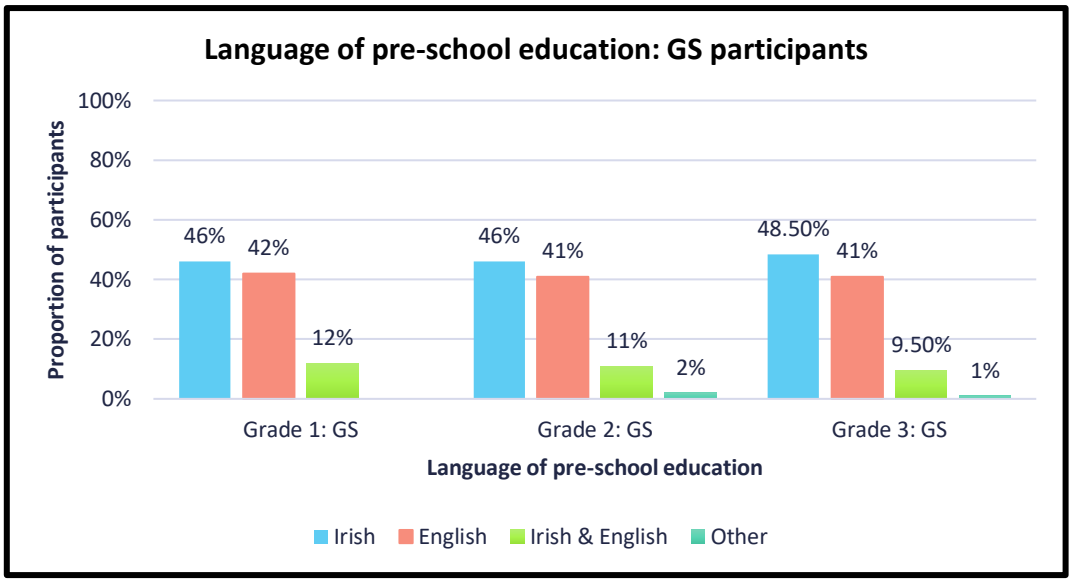

Figure 10 Gaelscoil participants: language of pre-school education as reported by parents/guardians

Grade 1. All of the GT participants had attended some type of Irish-medium pre-school education. There was more variation in the GS group, where 46% of participants attended Irish-medium early childhood education, 42% attended English-medium education and 12% attended early childhood education in Irish for a period, and in English for a period.

Grade 2. All except one of the Gaeltacht participants had attended Irish-medium pre-school education. Of those in Gaelscoileanna, 46% attended Irish-medium early childhood education, 41% attended English-medium education, 11% attended both Irish and English early childhood education and 2 participants attended early childhood education in another language

Grade 3. All of the GT participants had attended Irish-medium pre-school education. Again, there was more variation in the GS group, 48.5% attended Irish-medium early childhood education, 41% attended English-medium education, 9.5% attended both Irish and English early childhood education and 1 participant attended early childhood education in another language.

It is of note that the vast majority of those in Gaeltacht schools availed of pre-school education through Irish, particularly in light of the fact that the majority of pre-schools operate through the medium of English in Gaeltacht areas (just 59 of the 127 pre-schools in Gaeltacht areas operated through the medium of Irish in 2018: Comhchoiste na Gaeilge, na Gaeltachta agus na nOileán, 2019). This may be due to the proximity of particular pre-schools to participating schools, and/or may indicate a self-selection bias in favour of children who have had more exposure to Irish. The importance of education through Irish in the early years and its effect on later language skill is recognised and promoted as part

of the Polasaí don Oideachas Gaeltachta 2017-22 (Department of Education and Skills, 2016).

5.5.2 Parents/guardians' native language

The native language reported by parents and guardians of participants is detailed in Table 11 (Gaeltacht participants) and Table 12 (Gaelscoil participants). The majority of the parents/guardians in the GT group were native speakers of Irish, while the majority of the parents/guardians of the GS group were native speakers of English. The vast majority of those in the GT group (58 of the 63 participants) had one or more parent/guardian who is a native Irish speaker.

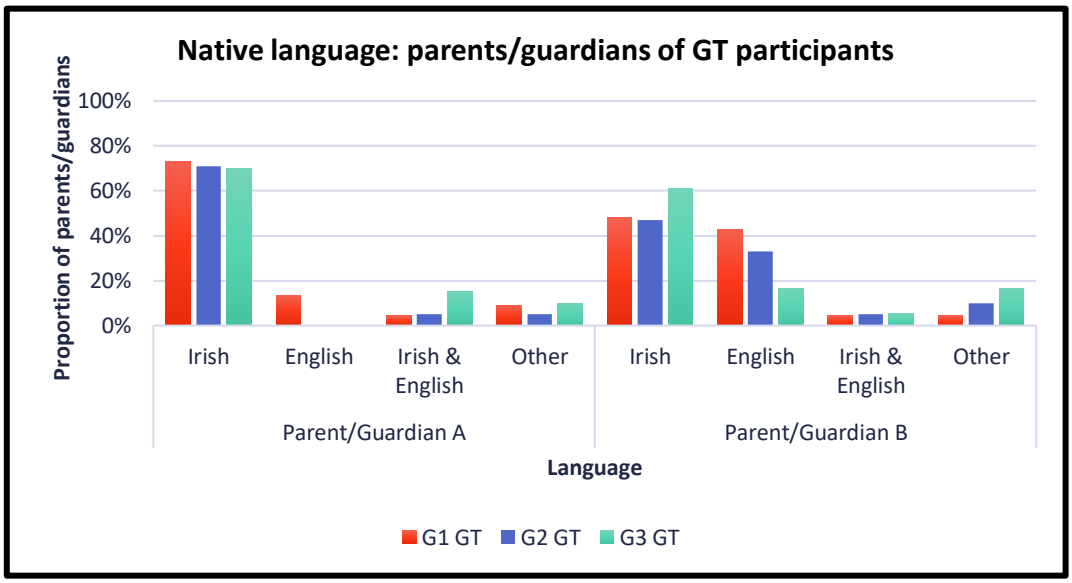

Figure 11 Gaeltacht participants: native language reported by parents/guardians

Grade 1 GT participants. The majority of the Grade 1 GT participants' parents/guardians were native Irish speakers. Of the 22 people who responded as Parent/Guardian A, 16 (73%) reported that Irish was their native language, 3 reported that English was their native language, 1 reported that they were native speakers of both Irish and English, and 2 reported another language as their native language. Of those who responded as Parent/Guardian B, 10 (48%) reported that Irish was their native language, 9 reported that English was their native language, 1 reported that they were native speakers of both English and Irish, and 1 reported that they had another native language. Of the 22 participants, 19 had one or more native Irish-speaking parents/guardians.

Grade 2 GT participants. The majority of the Grade 2 GT participants' parents/guardians were native Irish speakers. Of the 21 people who responded as Parent/Guardian A, 15 (71%) indicated that Irish was their native language, 4 reported that English was their native language, 1 reported that they were native speakers of both Irish

and English, and 1 reported another language as their native language. Of the 19 who responded as Parent/Guardian B, 9 (47%) reported that Irish was their native language, 7 reported that English was their native language, 1 reported that they were a native speaker of both Irish and English and 2 reported another language as their native language. Of the 21 participants, 19 have at least one native speaker parent.

Grade 3 GT participants. The majority of the Grade 3 GT participants' parents/guardians were native Irish speakers. Of the 20 people who responded as Parent/Guardian A, 14 (70%) reported that Irish was their native language, 1 reported that English was their native language, 3 reported that they were native speakers of both Irish and English, and 2 reported another language as their native language. Of the 18 who responded as Parent/Guardian B, 11 (61%) reported that Irish was their native language, 3 reported that English was their native language, 1 reported that they were native speakers of both English and Irish and 3 reported another language as their native language. Every child in this group had at least one parent who is a native speaker of Irish.

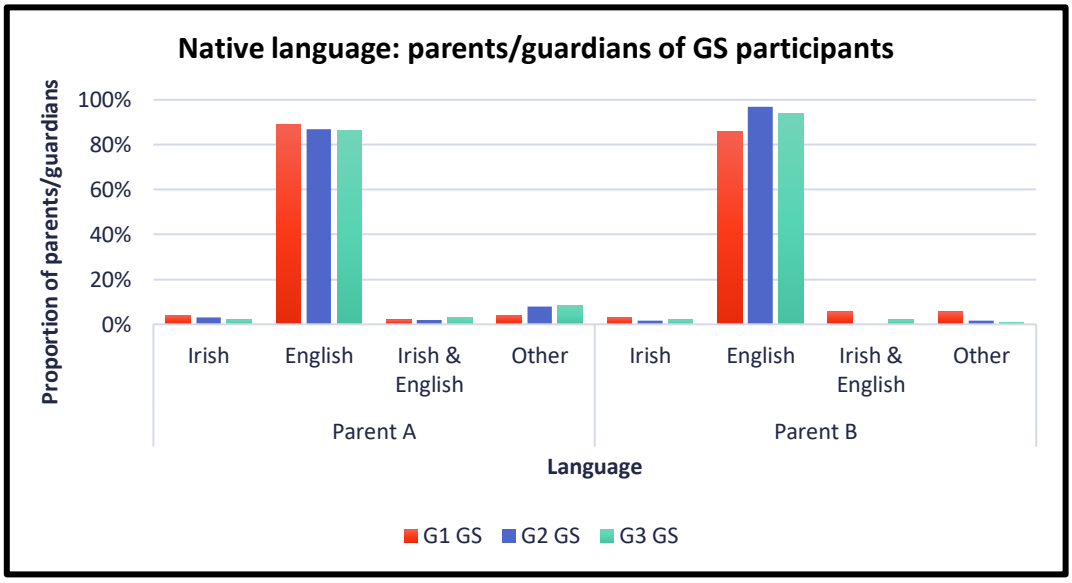

Figure 12 Gaelscoil participants: native language reported by parents/guardians

Grade 1 GS participants. The majority of the Grade 1 GS participants' parents/guardians were native English speakers. Of the 83 people who responded as Parent/Guardian A, 74 (89%) reported that English was their native language, 3 reported that Irish was their native language, 2 reported that they were native speakers of both Irish and English, and 4 reported another language as their native language. Of those who responded as Parent/Guardian B, 61 (86%) reported that English was their native language, 2 reported that Irish was their native language, 4 reported that they were native speakers of both English and 4 reported another language as their native language.

Grade 2 GS participants. The majority of the Grade 2 GS participants' parents/guardians were native English speakers. Of the 94 people who responded as Parent/Guardian A, 82 (87%) reported that English was their native language, 3 reported that Irish was their native language, 2 reported that they were native speakers of both Irish and English, and 7 reported another language as their native language. Of those who responded as Parent/Guardian B, 72 (94%) reported that English was their native language, 2 reported that Irish was their native language, and 2 reported another language as their native language.

Grade 3 GS participants. The majority of the Grade 3 GS participants' parents/guardians were native English speakers. Of the 105 people who responded as Parent/Guardian A, 91 (87%) reported that English was their native language, 2 reported that Irish was their native language, 3 reported that they were native speakers of both Irish and English, and 9 reported another language as their native language. Of the 89 who responded as Parent/Guardian B, 84 (94%) reported that English was their native language, 2 reported that Irish was their native language, 2 reported that they were native speakers of both English and Irish and 1 reported another language as their native language.

5.5.3 Frequency of Irish language communication at home

The frequency with which parents/guardians reported communicating with their child is illustrated in Figure 13 and described below. The majority of GT respondents indicated that they always or very often spoke Irish to their child at home, while the majority of the GS respondents indicated that they rarely or never spoke Irish to their child at home, though there is substantial within-group variation.

GT participants. Of those who responded as Parent/Guardian A, the majority reported that they always or very often spoke Irish to their child at home (78% in Grade 1; 86% in Grade 2; 90% in Grade 3). A number of respondents indicated that they communicated with their child in Irish half the time (23% in Grade 1; 5% in Grade 2; 10% in Grade 3), and a number of respondents in Grade 2 indicated that they rarely or never spoke to their child in Irish at home (10% in Grade 2).

Of those who responded as Parent/Guardian B, the majority reported that they always or very often spoke Irish to their child at home (59% in Grade 1; 68% in Grade 2; 65% in Grade 3). A number of respondents indicated that they communicated with their child in Irish half the time (5% in Grade 1; 11% in Grade 2; 5% in Grade 3), and some respondents indicated that they rarely or never spoke to their child in Irish at home (9% in Grade 1; 21% in Grade 2; 10% in Grade 3).

GS participants. Of those who responded as Parent/Guardian A, the majority reported that they rarely or never spoke Irish to their child at home (55% in Grade 1; 46% in Grade 2; 58% in Grade 3). A number of respondents indicated that they communicated with their child in Irish half the time (25% in Grade 1; 32% in Grade 2; 27% in Grade 3), and some indicated that they always or very often spoke to their child in Irish at home (19% in Grade 1; 21% in Grade 2; 16% in Grade 3).

Of those who responded as Parent/Guardian B, the majority reported that they rarely or never spoke Irish to their child at home (76% in Grade 1; 66% in Grade 2; 75% in Grade 3). Some indicated that they communicated with their child in Irish half the time (10% in Grade 1; 16% in Grade 2; 10% in Grade 3), and some indicated that they always or very often spoke to their child in Irish at home (19% in Grade 1; 21% in Grade 2; 16% in Grade 3).

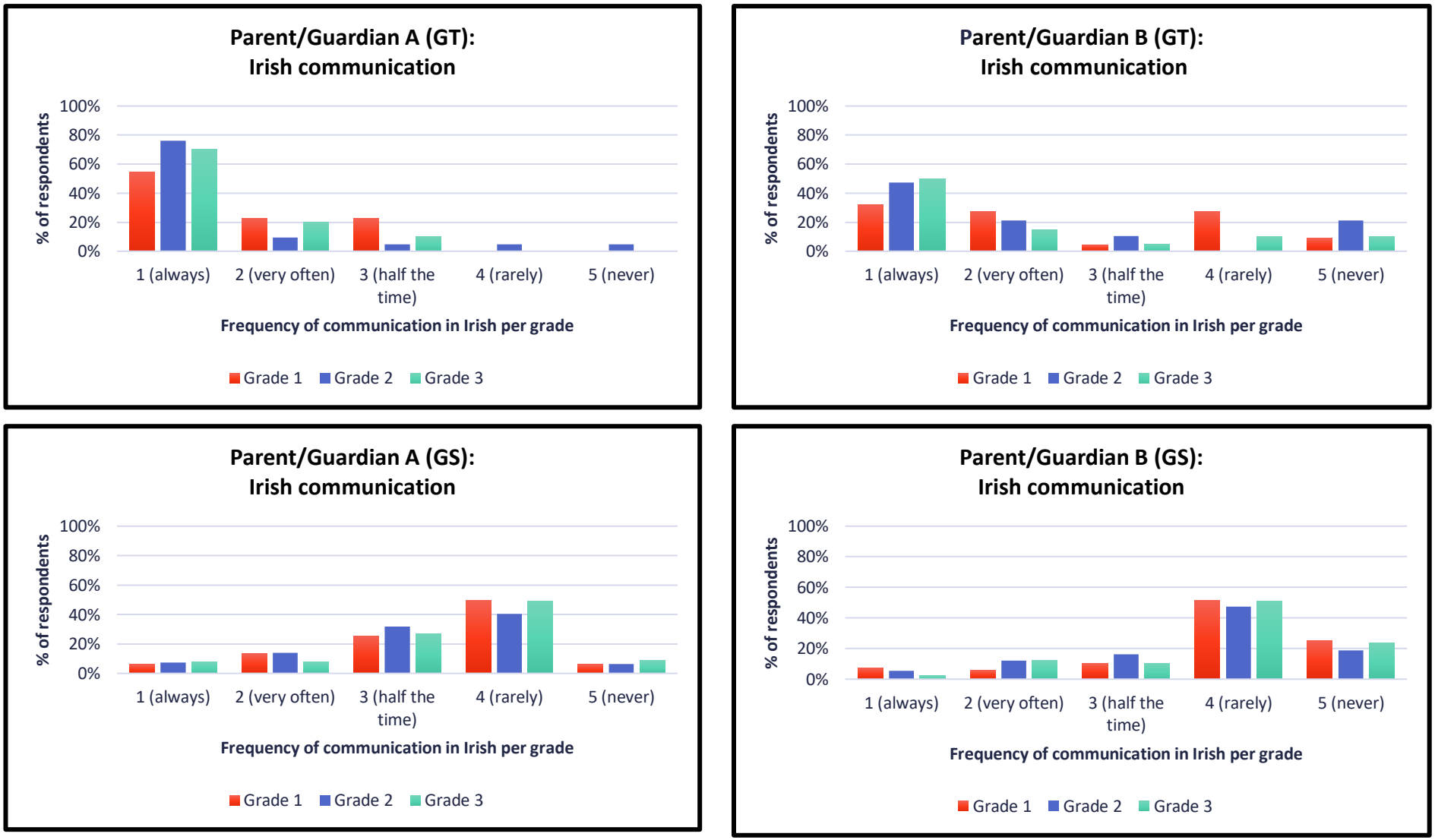

Figure 13 Gaeltacht and Gaelscoil participants: frequency of communication in Irish at home as reported by parents/guardians

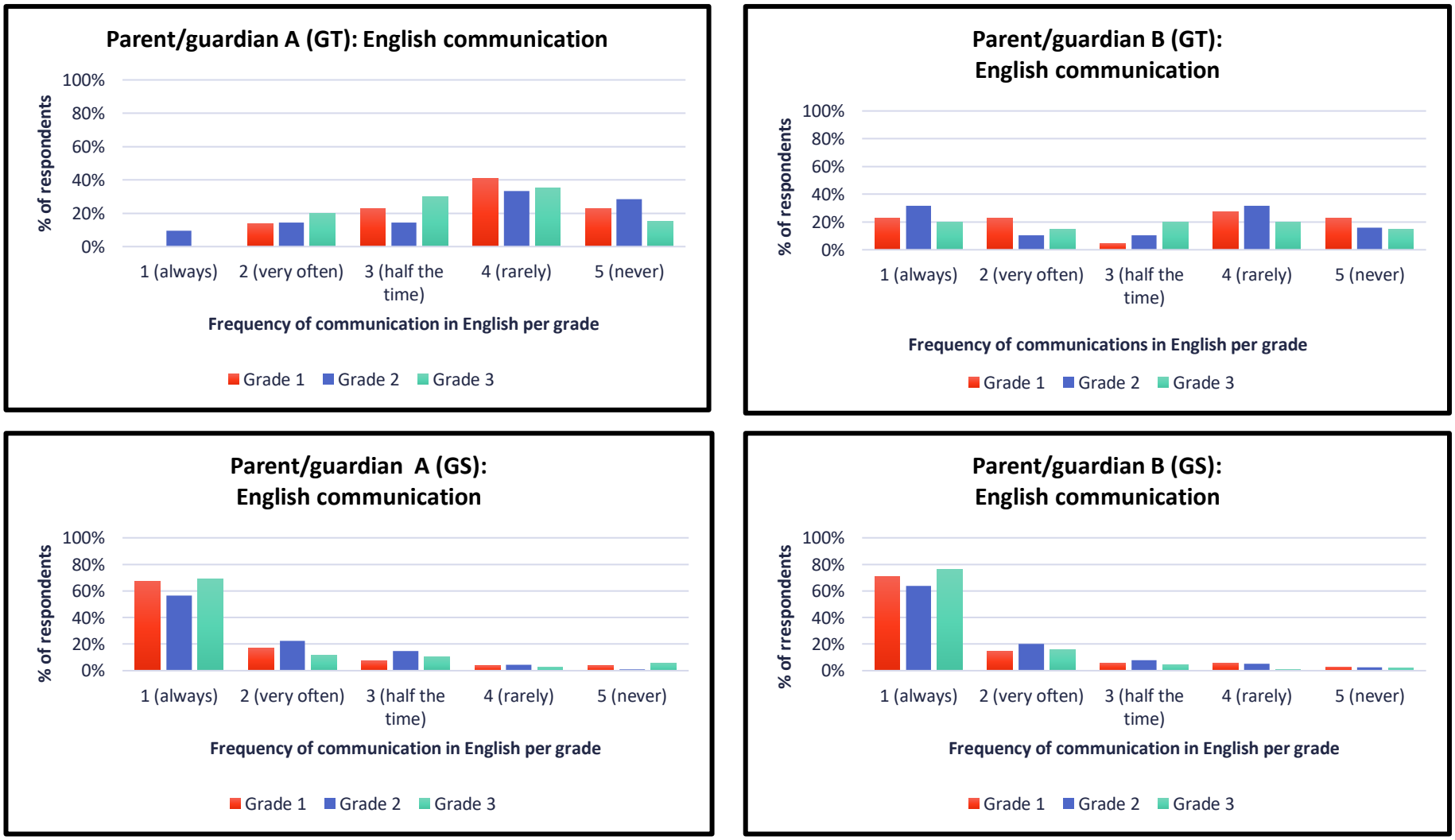

Figure 14 Gaeltacht and Gaelscoil participants: frequency of communication in English at home as reported by parents/guardians

5.5.4 Frequency of English language communication at home

The frequency with which parents and guardians reported communicating with their child in English is illustrated in Table 14 and described below. The majority of GT respondents indicated that they rarely or never spoke English to their child at home, while the majority of the GS respondents indicated that they always or very often spoke English to their child at home. Again, there is substantial within-group variation.

GT participants. Of those who responded as Parent/Guardian A, the majority reported that they rarely or never spoke English to their child at home (64% in Grade 1; 62% in Grade 2; 50% in Grade 3). A number of respondents indicated that they communicated with their child in English half the time (23% in Grade 1; 14% in Grade 2; 30% in Grade 3), and some indicated that they always or very often spoke to their child in English at home (14% in Grade 1; 14% in Grade 2; 20% in Grade 3).

Of those who responded as Parent/Guardian B, a number reported that they rarely or never spoke English to their child at home (50% in Grade 1; 48% in Grade 2; 35% in Grade 3) while similar numbers reported that they always or very often spoken English to their child (46% in Grade 1; 43% in Grade 2; 35% in Grade 3). Some respondents indicated that they communicated with their child in English half the time (5% in Grade 1; 11% in Grade 2; 20% in Grade 3)

GS participants. Of those who responded as Parent/Guardian A, the majority reported that they always or very often spoke English to their child at home (84% in Grade 1; 78% in Grade 2; 81% in Grade 3). A number of respondents indicated that they communicated with their child in English half the time (7% in Grade 1; 14% in Grade 2; 11% in Grade 3), and some respondents indicated that they rarely or never spoke to their child in English at home (8% in Grade 1; 5% in Grade 2; 9% in Grade 3).

Of those who responded as Parent/Guardian B, the majority reported that they always or very often spoke English to their child at home (86% in Grade 1; 84% in Grade 2; 92% in Grade 3). A number of respondents indicated that they communicated with their child in English half the time (6% in Grade 1; 8% in Grade 2; 5% in Grade 3), and some respondents indicated that they rarely or never spoke to their child in English at home (3% in Grade 1; 3% in Grade 2; 2% in Grade 3).

5.5.5 Frequency of communication in an additional language at home

GT participants. Of those who responded as Parent/Guardian A, the vast majority indicated that they never communicated with their child in a language other than Irish and English in the home (100% in Grade 1; 95% in Grade 2; 100% in Grade 3). Just one

Parent/Guardian A respondent in Grade 2 indicated that they always spoke to their child in another language.

Of those who responded as Parent/Guardian B, the vast majority indicated that they rarely or never communicated with their child in a language other than Irish and English in the home (100% in Grade 1; 100% in Grade 2; 95% in Grade 3). Just one Parent/Guardian A respondent in Grade 2 indicated that they spoke to their child in another language half the time.

GS participants. Of those who responded as Parent/Guardian A, the vast majority indicated that they rarely or never spoke to their child in another language (96% in Grade 1; 98% in Grade 2; 97% in Grade 3). A small number of respondents indicated that they always or very often communicated with their child in another language (2% in Grade 1; 1% in Grade 2; 2% in Grade 3) and one respondent of a Grade 2 participant indicated that they spoke another language half the time with the child.

Of those who responded as Parent/Guardian B, the vast majority indicated that they rarely or never spoke to their child in another language (94% in Grade 1; 100% in Grade 2; 98% in Grade 3). A small number of respondents indicated that they always or very often communicated with their child in another language (5% in Grade 1; 1% in Grade 3).

5.6 Research instruments

The measures used in this study were experimental; their development is described in Chapter 4. The tasks used to measure each variable, their requirements, structure and practice items are outlined in Table 23 below.

Table 23
Requirements, format and practice items pertaining to the tasks used in the present study

Variable Name	Task	Requirement	Stimuli	Practice Items	Grade 1	Grade 2	Grade 3
Linguistic phonemic awareness	Phoneme Matching task	Indicate whether two words start with the same sound	24 pairs (12 matching; 12 mismatching): -16 consonant items -8 vowel items	Six practice items: - 2 consonant matches (1 orthographically opaque; 1 orthographically transparent item in English) - 2 consonant mismatches (including 1 velarised-palatalised mismatch in Irish; 1 orthographically opaque; 1 orthographically transparent item in English) - 2 vowel items	✓	✓	✓
Metalinguistic phonemic awareness	Phoneme Deletion task	Delete (i) an initial single consonant (ii) an initial consonant from a cluster and (iii) the final consonant from a word	5 initial single phoneme deletions; 4 initial phoneme deletions from a cluster; 3 final phoneme deletions	2 practice items for each condition. In each case, the target word of one practice item was a real word and the target word of the other practice item was a nonword.		✓	✓
Rapid automatised naming	RAN Objects task	Name the objects on the page as quickly as possible	Seven rows of five objects (same five objects, repeated in a different order)	A single line of five objects.	✓	✓	✓
Verbal short-term memory	Forward Word Span task	Repeat the list of words you hear. The list increases from two words to eight words.	A list of between 2 and 8 monosyllabic words	A two-word list	✓	✓	✓

Productive Vocabulary	Productive Vocabulary task	Name the objects you see on the screen	45 pictures (presented five at a time)	No practice items included due to the simplicity of the task	✓	✓	✓
Letter Knowledge	Letter Naming task	Name the letters you see on the screen	10 letters (presented one at a time)	One practice item (a single letter)	✓		
Word reading accuracy	Word Reading task	Read the list of words on the page (Grade 2). Read the list of words on the page and I will stop you after two minutes (Grade 3).	20 words (Grade 2) 40 words (Grade 3)	No practice items.		✓	✓
Spelling accuracy	Spelling task	Write the words you hear on the whiteboard.	8 words	No practice items.			✓

5.6.1 Validity

In the context of psychometric or education testing, validity refers to the extent to which interpretations of test scores are supported by evidence and theory (Messick, 1989). Classical definitions of validity consist of three different categories: content, construct, and criterion validity (Cronbach & Meehl, 1955). There exists a number of controversies in validity theory. Some researchers disregard the relevance or legitimacy of construct validity for example (e.g. Borsboom et al, 2009), while others subsume all other types of validity under it (e.g. Messick 1995, Strauss & Smith, 2009).

The extent to which a unitary conceptualisation of validity is logical or useful is beyond the scope of this section[40]. For the purposes of this study, a classical approach to validity is adopted in which content, construct and criterion validity are examined individually. A number of the research questions in this study are directly concerned with different aspects of validity. For example, RQ2 and RQ5 investigate various factors involved in construct validity, while RQ6 examines the criterion validity of the independent variables. In this sense, validity is explored as a primary focus of this study, rather than as a characteristic of individual measures in this study.

Content validity. Content validity refers to the degree to which elements of a research instrument (stimuli, instructions, practice items, responses) are relevant to and representative of the domain tested for a given assessment purpose (Haynes, Richard & Kubany, 1995). Though there has been controversy surrounding the definition of content validity, there is consensus that domain representation and domain relevance are essential to its definition (Sireci, 1998). Domain representation refers to the notion that all relevant facets of the domain should be represented; domain relevance indicates that elements extraneous to the domain should not be included. The content validity of the measures used in the present study can be assessed based on the data presented in Chapter 4, in which the rationale and justification for the utilisation of specific task types and for the inclusion of particular stimuli are provided. The specificity of each domain is outlined in § 4.3, in which the restrictions on stimuli included in the task are outlined.

Construct validity. Construct validity refers to the degree to which a measure used in a study or assessment reflects the theoretical construct they claim to measure (Davis, 1989). In this sense, construct validity is inherently linked to theory. Construct validity is typically examined using a correlationary analysis between the measure of interest and other measures. The measure of interest should correlate with measures with which it has

[40] Sireci (2007) draws interesting conclusions on this matter.

a theoretical relationship (convergent validity) and not with measures with which it does not (discriminant validity; Westen & Rosenthal, 2003). This follows from Cronbach and Meehl's seminal (1955) paper on the topic which defined a construct in terms of the network of association in which it occurs. The process of construct validation is more complex, incremental and expansive than a correlation matrix in a single study, however. Fundamentally, construct validity is examined and refined by the pattern of findings of many different kinds of studies which provide an indication of how well a measure measures what it is purported to (Wagner & Skawronksi, 2019).

In the present study, construct validity is relevant to the independent variables of LPA, MPA, RAN and VSTM as they are theoretical constructs which are assessed using a measure designed for this study. It does not as readily apply to Letter Knowledge, Productive Vocabulary or to the dependent variables of Word Reading accuracy and Spelling accuracy as these are tested in a direct manner. Of particular interest in this study is the validity of LPA and MPA as unitary constructs across languages, explored in § 6.2. Another aspect of their construct validity is examined in § 7.1, which provides insight into the extent to which these tasks measure purely phonological ability or are influenced by orthographic knowledge.

Criterion validity. Criterion validity is an indication of how well a measure predicts performance on a given criterion (Glover & Albers, 2007). It is typically studied when developing a measure which is a substitute for an existing measure (e.g. a computer-based version of an established paper-based reading test) or when there is a measure has been shown to correlate with a criterion (Cronbach & Meehl, 1955). It is perhaps the simplest category of validity and the most straightforward to measure.

Criterion validity is of interest for all of the predictor variables and is examined using multiple methods in the present study. First, the correlation matrix in § 8.1.4 indicates the degree of correlation between each of the independent (predictor) variables and the dependent (criterion) variables. In addition, the hierarchical regression analyses in § 8.2 - § 8.6 indicates how much of the variance in the dependent variable is predicted by the variance in the independent variables.

5.6.2 Reliability

There are a number of types of reliability and ways to evaluate it, including internal consistency, test-retest reliability and interrater reliability. Interrater reliability does not apply to this study as only a single tester was required due to the simplicity of the tasks and responses. Due to the time constraints as well as the already large time commitment of participants, it was not possible to gather data which would allow for test-retest reliability

to be examined. The test-retest reliability of similar measures in other languages are detailed below, however. Measures of internal consistency are provided for tasks in which responses on individual items are scored. Values above .7 are deemed to be adequate (Wagner & Skawronksi, 2019).

Internal consistency. Two measures of internal consistency were used. Cronbach's alpha was used for tasks which did not contain multiple conditions (i.e. had a unidimensional scale). In contrast, for tasks with more than one condition (Phoneme Matching task and Phoneme Deletion task), internal consistency was examined using Guttman's λ 4 split-half reliability coefficient. In the case of heterogenous data of this kind, the λ 4 coefficient is a good alternative to Cronbach's Alpha (Osburn, 2000; Ten Berge & Sočan, 2004). Guttman's coefficient calculates the covariance between participants' scores on each half as well as the variance on the total test score. The reliability coefficient is calculated by dividing the covariance of the two halves by the total variance on the test (Benton, 2015). In the case of each task, all of the data collected (for all grades in all schools) was analysed together.

For the Phoneme Matching task, the items were split into two halves, each of which contained the same number of items from each condition (4 matching consonants; 4 mismatching consonants; 2 matching vowels and 2 mismatching vowels each). Guttman's λ 4 split-half reliability coefficient was .74 for Irish Phoneme Matching task and .74 for English. The Phoneme Deletion task consists of three different conditions: deletion of single initial phoneme (5 items), deletion of a phoneme from a cluster (4 items) and deletion of a final phoneme (3 items). The twelve stimuli in this task were divided in two halves, each containing six items[41]. The analysis returned a coefficient of .82 for the Irish version of the task and .84 for the English version of the task.

Cronbach's Alpha was used to evaluate the internal consistency of tasks which did not have component conditions. For the spelling task, it returned a coefficient of .72 for the English version of the task and .70 for the Irish version of the task. For the Letter Naming task, the analysis returned a coefficient of .86 and for the Productive Vocabulary task, it returned a coefficient of .79.

Test-retest reliability. Though test-retest reliability was not established in the present study, the reliability of similar tasks are adequate to high. The test-retest of the original RAN Objects task (designed by Denckla & Rudel, 1974) – on which the RAN task

[41] One half contained 3 items from the first condition (initial phoneme deletion), 2 items from the second condition (initial phoneme deletion from a cluster) and one item from the third condition (final phoneme deletion); the other contained 2 items from the first condition, 2 items from the second condition and 2 items from the third condition.

used in this study was based - was found to be .80 for 5-6 year olds (Blachman, 1984). Test-retest reliability of a similar Forward Word Span task in a previous study was found to be adequate (.76 in a large sample of schoolchildren; Alloway et al, 2006). Word Reading test-test reliabilities are typically high (e.g. .97 for the Test of Word Reading Efficiency; Torgesen, Rashotte & Wagner, 1999). As these are not the exact tasks used in this study, these values are purely indicative. Even if these particular tasks had been used in this study, reliability values technically only relate to the population on which they are established (Wilkinson & The APA Task Force on Statistical Inference, 1999). Therefore, additional data is necessary in order to establish the test-retest reliability of tasks used in the present study.

5.7 Data collection procedures

The procedures used during the data collection process are outlined in this section, including the location of data collection the period over which data was collection, the administration procedures and the limitations of the procedures.

5.7.1 Location

All of the tasks were carried out in the participating schools. In each school, the tasks were carried out in a quiet part of the school with no visual distractions.

5.7.2 Time frame

The data collection period began on the 7th of January 2019 and finished on 6th of June 2019. It was decided to begin with the study with the Grade 3 pupils, as they had spent the most time in school up to the initial time point of data collection (2.5 years). This was followed by the Grade 2 and finally the Grade 1, who had spent less than a year in school. A week was scheduled per class group, and if a child was absent on the allotted week an effort was made to carry out the tasks at a different time. This happened in a small number of cases, and they were accommodated within the same age group block. Ideally, the data collection would have been conducted with the Gaeltacht participants in the same time frame as Gaelscoil participants of the same age, however this was not possible for a number of logistical reasons. The data collection schedule is provided in Appendix 8.

5.7.3 Task administration and child-friendly practice

Consent was obtained from all participants' parents/guardians, however formal (written) assent was not sought for this study from the children. Initial conversations with teachers indicated that the majority of the children involved would not have the ability to read and comprehend written information leaflets. There were also concerns that the concept of the

study may be abstract to children, and that it would be preferable for them to see the study set up. As such, when beginning the study with each new class, I introduced myself and told the children about the study in plain language and showed them the type of activity involved briefly using the tablet. I ensured they were aware that they did not have to take part in the study, and that if they wanted to, they could decide they no longer wanted to take part in the study and come back to the classroom at any time. Then, teachers asked children on the list if they were happy to take part in the study. The majority of children were happy to take part, though a small number – outlined in section § 5.3.5 – did not wish to be involved.

A randomised class list of the participating students was provided to the teacher, who asked sent each participating child out in turn. In the case of Grade 1 and Grade 2 participants, I walked with them from the classroom to the task administration site. The Grade 3 pupils walked to the site themselves and then returned to the classroom and sent the next student. I spoke to each child for a short time before beginning the tasks to develop a rapport with them; conversation centered around topics relevant to their lives, including pastimes, pets, siblings and school subjects. I made every child aware that they had done a great job after each task and at the end of the session. The development of game-based tasks had been informed by participants' engagement with tasks during the pre-testing phase of design, and children appeared to enjoy this element in the main study too.

The tasks were carried out on a Samsung Galaxy Tab A tablet, and a wireless keyboard was used to advance through the tasks. Both the participant and I wore noise-cancelling Beyerdynamic headphones. There were a small number of participants who did not wish to wear the headphones and they were accommodated at a quiet time of the day to ensure that they could hear each stimulus and concentrate on the tasks. The setup included a desk with the tablet in the centre of the table, and materials for the tasks to the right of the tablet. I sat on the right-hand side and the participant sat on the left. Responses were discretely marked in a record book which was held on a clip board out of the sight of the participant.

For each task, the participant was introduced to the scenario or narrative and given instructions detailing what they were required to do. The majority of the tasks had a number of practice items (outlined in table Chapter 4). If the participant gave the correct answer to a practice item, they moved on to the next item. If the participant gave an incorrect answer, the correct answer was displayed and was further explained when necessary.

Each language version of the task battery took between 20 and 25 minutes for Grade 3 pupils, between 15 and 20 minutes for Grade 2 pupils and approximately ten minutes for Grade 1 pupils. This included a few minutes at the start of talking to the child about general

topics to put them at ease. When the participant was ready, the task was initiated. If it became apparent at any time that the participant did not wish to continue, they were asked if they would prefer to go back to the classroom. A small number of participants – outlined in section § 5.3.5 – did not wish to continue and they were assured that that was not a problem.

A sample of the record book in which responses were recorded is included in Appendix 4. Each language version of the tasks was carried out with the participant during the same school day (at least two hours apart from one another). The English language version of the tasks were carried out first with approximately half of the participants, and the Irish language version of the tasks are carried out first with the other half.

5.7.4 Implementation issues and limitations

While overall the implementation of the study was successful, there were a small number of issues. The first was noise-related. If there was an incident of noise (e.g. an announcement on the intercom or people speaking in the corridor) the task was suspended and resumed when the noise stopped. For the non-timed tasks, the task resumed from the previous stimulus. The RAN task was re-started from the beginning as it was timed.

The second was motivation. While the design of the tasks aimed to maximise motivation, there was variation in terms of the participants' motivation to complete the task. This is a reflection of natural variation in personality traits and interests in the population. With that said, it is likely that this is a confounding variable, albeit one that is difficult to measure and quantify. This is a limitation of the study, and it is a methodological factor which could be improved upon in other studies by attempting to quantify motivation levels.

5.8 Data preparation and analysis

This section outlines the procedures followed in data preparation (§ 5.8.1) as well as the decisions made in relation to data analysis. As the distribution of the data is an important factor in the decision-making process, the results of Shapiro-Wilk (1965) test which assesses normality as well as values of skewness and kurtosis are reported in § 5.8.2. A justification and explanation of statistical analysis methods are provided in section § 5.8.3. The treatment of extreme values and outliers is discussed in § 5.8.4.

5.8.1 Data preparation

The data was entered directly from each record book to an Excel sheet. The data validation tool in Excel was used to restrict data input in order to avoid data entry errors. The entered

data was subsequently checked against the record book to check for any errors not detected by the data validation tool.

5.8.2 Distribution of data

The distribution of data for each measure is reported here as it informed the choice of statistical methods used in this study. A Shapiro-Wilk test (1965) was conducted to evaluate whether the data had a normal distribution. This tests the null hypothesis that a sample derived from a normally-distributed population. If this hypothesis is violated (i.e. $p<0.05$), the data is assumed to come from a non-normal population. For the majority of the tasks, the distribution was not normal ($p>0.05$). This is not an unexpected finding; data pertaining to constrained skills (such as phonemic awareness and word reading) are typically not normally-distributed, and in this case the use of non-parametric statistical methods are advised (Paris, 2005). The statistic pertaining to the Shapiro-Wilk test, along with skewness and kurtosis statistics are reported in the tables below.

Grade 1. Normality, skewness and kurtosis statistics for the Grade 1 data are provided in Table 24. For the majority of measures, the scores are not normally distributed. Only the GS group Irish RAN scores, the GT group English RAN scores and the GT group Irish Productive Vocabulary scores were normally distributed ($p>0.05$).

Table 24
Normality, skewness and kurtosis statistics (Grade 1 data).
Note: GA = Irish; EN = English; GS = Gaelscoil; GT = Gaeltacht

		Shapiro-Wilk Test			Skewness		Kurtosis	
Task	Sample	Statistic	df	Sig.	Statistic	St. Error	Kurtosis	St. error
Phoneme Matching (GA)	GS	.842	83	.000	-1.720	.264	3.721	.523
	GT	.816	22	.001	-2.098	.491	6.716	.953
Phoneme Matching (EN)	GS	.918	83	.000	-1.220	.264	3.241	.523
	GT	.878	21	.013	-1.573	.501	4.290	.972
RAN (GA)	GS	.974	83	.085	.465	.264	1.234	.523
	GT	.864	22	.006	.943	.491	-.235	.953
RAN (EN)	GS	.970	83	.048	.104	.264	1.612	.523
	GT	.929	21	.132	-.478	.501	-.172	.972
Forward Word Span (GA)	GS	.869	83	.000	1.047	.264	1.022	.523
	GT	.842	22	.002	.897	.491	-.039	.953
	GS	.863	83	.000	.720	.264	-.468	.523

Forward Word Span (EN)	GT	.878	21	.013	.752	.501	1.163	.972
Letter Naming	GS	.855	82	.0000	-1.392	.266	2.109	.526
	GT	.875	22	.010	.251	.491	-1.012	.953
Productive Vocabulary (GA)	GS	.966	83	.029	-.512	.264	.385	.523
	GT	.960	22	.480	.307	.491	-.019	.953

Grade 2. Normality, skewness and kurtosis statistics for the Grade 2 data are provided in Table 25. For the majority of measures, the scores are not normally distributed. Only the GT group Irish Phoneme Matching scores, the GT group English Phoneme Matching scores, the GT group English RAN scores and the GT group Irish Productive Vocabulary scores were normally distributed ($p>0.05$).

Table 25
Normality, skewness and kurtosis statistics (Grade 2 data).
Note: GA = Irish; EN = English; GS = Gaelscoil; GT = Gaeltacht

		Shapiro-Wilk Test			Skewness		Kurtosis	
Task	Sample	Statistic	df	Sig.	Statistic	St. Error	Kurtosis	St. error
Phoneme Matching (GA)	GS	.931	94	.000	-.906	.249	.845	.493
	GT	.944	21	.266	-.069	.501	1.434	.972
Phoneme Matching (EN)	GS	.933	94	.000	-.812	.249	.329	.493
	GT	.923	21	.100	.664	.501	.302	.972
Phoneme Deletion (GA)	GS	.891	94	.000	-.434	.249	-1.172	.493
	GT	.851	21	.004	-.416	.501	-1.438	.972
Phoneme Deletion (EN)	GS	.920	94	.000	-.462	.249	-.998	.493
	GT	.884	21	.017	-.218	.501	-1.539	.972
RAN (GA)	GS	.859	94	.000	1.604	.249	3.049	.493
	GT	.808	21	.001	1.571	.501	1.893	972
RAN (EN)	GS	.882	94	.000	1.346	.249	1.721	.493
	GT	.921	21	.091	1.085	.501	1.723	.972
Forward Word Span (GA)	GS	.849	94	.000	.790	.249	-.390	.493
	GT	.810	21	.001	.517	.501	-.876	.972
Forward Word Span (EN)	GS	.865	94	.000	.597	.294	.048	.493
	GT	.849	21	.004	.832	.501	.068	.972
Word Reading (GA)	GS	.928	94	.000	.018	.249	-1.360	.493
	GT	.901	21	.001	-.418	.501	-.894	.972
	GS	.948	94	.001	-.897	.249	1.241	.493

Productive Vocabulary (GA)	GT	.953	21	.385	.180	.501	.158	.972

Grade 3. Normality, skewness and kertosis statistics for the Grade 3 data are provided in Table 26. For the majority of measures, the scores are not normally distributed. Only the GT group Irish Phoneme Matching scores, the GT group English Phoneme Matching scores, the GT group English Forward Word Span scores, the GT group Irish Spelling scores, and the Irish Productive Vocabulary scores for both groups were normally distributed ($p>0.05$).

Table 26
Normality, skewness and kurtosis statistics (Grade 3 data).
Note: GA = Irish; EN = English; GS = Gaelscoil; GT = Gaeltacht

		Shapiro-Wilk Test			Skewness		Kurtosis	
Task	Sample	Statistic	df	Sig.	Statistic	St. Error	Kurtosis	St. error
Phoneme Matching (GA)	GS	.939	105	.000	-.880	.236	1.472	.467
	GT	.937	20	.229	.266	.524	-.639	1.014
Phoneme Matching (EN)	GS	.906	105	.000	-1.206	.236	2.755	.467
	GT	.932	19	.186	-.798	.524	.586	1.014
Phoneme Deletion (GA)	GS	.884	105	.000	-.896	.236	-.018	.467
	GT	.508	20	.000	-3.352	.524	12.291	1.014
Phoneme Deletion (EN)	GS	.860	105	.000	-.983	.236	-.078	.467
	GT	.574	19	.000	-3.269	.524	12.097	1.014
RAN (GA)	GS	.939	105	.000	1.070	.236	1.747	.467
	GT	.835	20	.004	1.538	.524	2.134	.524
RAN (EN)	GS	.954	105	.001	.838	.236	.839	.467
	GT	.802	19	.001	1.629	.524	2.071	1.014
Forward Word Span (GA)	GS	.921	105	.000	.140	.236	-.933	.467
	GT	.928	20	.162	.468	.524	.001	1.014
Forward Word Span (EN)	GS	.890	105	.000	.233	.236	-1.058	.467
	GT	.877	19	.019	.611	.524	-.528	1.014
Word Reading (GA)	GS	.922	105	.000	-.293	.236	-1.246	.467
	GT	.829	20	.002	-1.399	.512	1.406	.992
Word Reading (EN)	GS	.903	105	.000	-.175	.236	-1.460	.467
	GT	.814	19	.002	-.800	.524	-.840	1.014
Spelling (GA)	GS	.962	105	.004	.020	.236	-.750	.467
	GT	.905	20	.051	-283	.512	-.836	.992

Spelling (EN)	GS	.952	105	.001	.253	.236	-.60	.467
	GT	.889	19	.031	-.588	.524	-.170	1.1014
Productive Vocabulary (GA)	GS	.984	105	.232	-.145	.236	-.186	.467
	GT	.960	20	.548	.035	.512	-.040	.992

5.8.3 Justification and explanation of statistical analysis methods.

An explanation of the statistical tests used to analyse data – the sign test, Kruskal-Wallis test and the hierarchical regression analysis – are provided in this section. Note that information pertaining to the assumptions of each test is discussed along with the results in Chapter 6, Chapter 7 and Chapter 8.

Sign Test. A sign test was chosen to examine whether there was any statistically significant difference between the performance of participants on the Irish and English versions of the tasks. This test was chosen as it makes no assumptions in relation to the distribution of data. The data did not meet assumptions for alternative tests such as a paired t-test (which assumes a normal distribution) and a Wilcoxon signed rank test (which assumes a symmetrical distribution). The disadvantage of a sign test is that is has less statistical power than parametric tests such as the t-test (Sprent & Smeeton, 2016).

In a sign test, the difference between pairs of values (e.g. Irish Phoneme Matching score, English Phoneme Matching score) is established for each participant. The median of these differences is calculated and the values above the median are assigned a positive sign while the values below the median are assigned a negative sign. If there is an equal number of positive signs and negative signs, the null hypothesis is true. Where there is an unequal number of positive and negative signs, the sign test evaluates what the probability is that this imbalance would occur given the null hypothesis.

Kruskal-Wallis test. A Kruskal-Wallis test was used to examine whether there was any statistically significant difference between three groups. This test was chosen as it does not assume that data is normally-distributed, though it does make other assumptions about the data. The null hypothesis typically states that the data derived from each sample comes from the same population. The alternative hypothesis is that the data comes from populations in which the observations of one of the populations is larger or smaller than the others (Vargha & Delaney, 1998).

In the Kruskal-Wallis test, the data from the samples are combined and ranked overall. They are then separated into the original samples and each mean rank is attached to the corresponding observation. If the samples derive from the same population, a similar

number of high, medium and low ranks would be expected, whereas if the sample derives from different populations one level of rank may dominate (Sprent & Smeeton, 2016).

Pearson and Spearman's Correlation. Correlation coefficients indicate the degree of linear association between two variables (Sprent & Smeeton, 2016). While Pearson's Correlation was used for the majority of analyses, Spearman's correlation coefficient was used when analysing correlations within small groups (e.g. within one grade of the GT group), as it is more robust to outliers (Mukaka, 2012) in comparison to Pearson's correlation.

Hierarchical regression analysis. A hierarchical regression analysis was chosen to examine whether the independent variables (as measured by Phoneme Matching, Phoneme Deletion, RAN, Forward Word Span and Productive Vocabulary tasks) predicted the dependent variables (Word Reading and Spelling). One of the assumptions of regression analysis is that the residuals (rather than the variables themselves) are normally-distributed; this assumption was met (discussed further in § 8.1).

This type of regression was selected as it allows for the input of data in blocks and indicates whether the addition of a variable or group of variables increase the accuracy of the model. This was necessary as RQ6 is interested in whether the independent variables predict reading over and above demographic variables (age, sex) and confounding variables (school, pre-school language, frequency of parental communication in Irish/English, parents/guardians' native language). A short explanation of hierarchical regression analysis is provided here, largely based on Lane (2003) and Winter (2019). Simple linear regression is first described, followed by multiple regression and finally hierarchical regression.

Simple linear regression describes the relationship between two variables. For example, Phoneme Deletion and Word Reading (WR) scores has been found in previous studies to have a positive linear relationship; if Phoneme Deletion score is plotted on the x-axis and WR score on the y-axis, their relationship can be approximated by a line. Two important characteristics of this line are the slope and the intercept, referred to as coefficients. In the case of Phoneme Deletion and WR scores, the line has a positive slope: when Phoneme Deletion scores increase, WR scores also increase. The intercept is the predicted mean value of y (WR score) when the value of x (Phoneme Deletion score) is 0. The equation for the regression line is specified by the slope (b_0) and the intercept (b_1):

$$y = b_0 + b_1 * x$$

In multiple regression, we can examine how much of the variance in the dependent variable is accounted for by multiple independent variables. The equation of the regression line is then:

$$y = b_0 + b_1 x + b_2 x + b_3 x + b_4 x$$

The points along the regression line are called fitted values. These are "idealised" values, not the values of any given data point. The distance between the fitted values and the actual values of the data points is specified by the residuals. The residuals quantify the amount of error in a model, and form part of the equation of the regression line:

$$y = b_0 + b_1 x + b_2 x + b_3 x + b_4 + e$$

Squaring and summing these residuals gives us the residual sum of squares (RSS), from which we can calculate R^2. In Ordinary Least Squares regression (used in this study), the parameters of a regression model are estimated by minimising the RSS.

R^2 is an important value in a regression model as it indicates how much of the variance in the dependent variable (WR attainment) is accounted for by the independent variables. Winter (2019) uses the concept of a null model to explain the calculation of R^2. A null model is a model with only an intercept, no slope. In the absence of a slope, the best estimate for the intercept is the mean of the dependent variable. The null model has a RSS, which we can compare to the RSS of our model. In this case, R^2 is calculated as:

$$R^2 = 1 - RRS_{model} / RRS_{null\ model}$$

The accuracy of the model is specified by the Standard Error of the Estimate (SSE), which is derived from the square root of the standard deviations of the residuals.

A hierarchical regression model (HRM) is a type of multiple regression model. In such a model, an initial set of variables is entered into a regression model[42]. Then, an additional set of variables are entered and the change in R^2 is examined to see whether there is any significant change in the amount of variance in the dependent variable accounted for by the independent variable. As previously mentioned, HRM was chosen for this study in order to partial out the unique variance explained by the predictor variables, over and above the demographic and language background variables.

[42] The order of entry should be determined by causal priority (Cohen & Cohen, 1983; Petrocelli, 2003), meaning that demographic variables and "third variables" should be input before experimental variables.

5.8.4 Treatment of extreme values and outliers

A recent review of outlier handling concluded that researchers' practice was often not based on systematic decision-making but on whether the outcome supported a researcher's favoured hypothesis (Aguinis, Gottfredson & Joo, 2013). A systematic and somewhat conservative approach was taken to maximise the reproducibility of this study.

Sign test and Kruskal-Wallis test. Before data analysis, the data was checked for extreme values or outliers by visual inspection of box plots for each of the tasks for each sample. A number of extreme values were identified, and the first step was to check whether any of these values were error outliers, for example values that are deviant as a result of errors in data recording, data input or computation. As the values were not errors, they were kept in the analysis. These extreme values represent true variability in the data set and removing them would falsely homogenise it. Decreasing variance in this manner is a possible source of bias (Kwak & Kim, 2017).

Hierarchical Regression analysis. For the hierarchical regression analysis, Cook's D was used to evaluate whether there were any prediction outliers. Those over a value of .1 were considered prediction outliers; the small number of prediction outliers removed are outlined in § 8.1

5.9 Limitations

There are various limitations to the present study. The first relates to the study design. A cross-sectional design was used which was satisfactory for the investigation of many of the research questions. However, for RQ6 - relating to the prediction of literacy attainment – it would have been more effective to have longitudinal data.

Another limitation relates to the availability of test-retest reliability coefficients. It was not possible to carry out an additional round of data collection for the purposes of examining test-retest reliability. The time commitment for participants was already high, given that they completed the task battery in two languages. However, alternative measures of reliability – pertaining to internal consistency – are reported for tasks for which all items are scored. Establishing the test-retest reliability of tasks is an area of possible future research.

Due to the nature of doctoral research work, I was the only researcher working on this project and it was not possible to carry out the data collection with each group concurrently. This meant that some participants had received more schooling and instruction than others at the time of data collection. While this is a limitation, the advantage to having a single researcher is that there is consistency across implementation for participants. However, the

time lag in relation to data collection, particularly between the GS groups and GT groups, precludes a between-group comparison of performance.

The number of participants in the GT group was relatively small, and the response rate was much lower than the GS group (42%). This introduces doubt in relation to the representativeness of the sample. The conclusions which can be drawn in relation to the GT group are likely to be weaker and less generalisable than those which relate to the GS group. This is an area in which the study could be extended in the future.

5.10 Chapter summary

This chapter described the methods used in the present cross-sectional study. A two-stage sampling method was employed and the response rate was 73% for those in Gaelscoileana was 42% for those in scoileanna Gaeltachta. The data of 345 participants from Grade 1, Grade 2 and Grade 3 in Gaelscoileana and scoileanna Gaeltachta are analysed in the final study.

The language background of the GS and GT participants differed substantially, as expected. All but one of the GT participants completed their pre-school education in Irish, whereas there was more variation in the language of pre-school education of the GS participants. In addition, the vast majority of the GT participants had at least one parent whose native language was Irish, whereas the majority of the GS participants' parents/guardians were native speakers of English.

The tasks used to measure the constructs of interest were outlined and issues related to their validity and reliability was discussed. The research questions which guide this study are motivated by certain aspects of construct and criterion validity, and the results discussed in later chapters provide further insight on these matters.

The data collection took place in participating schools over a period of five months, and though there were minor issues with implementation, overall it was successful. The methods used to analyse the data gleaned from this process was outlined, and explanations provided for the statistical tests used. Tests were chosen that were appropriate for the data collected in this study, given that the majority of the scores were not normally-distributed. The limitations of the study, outlined in this chapter, should be borne in mind in the interpretation of results in the chapters that follow.

CHAPTER 6

RESULTS: COMMON UNDERLYING PROFICIENCY AND BILINGUAL PHONEMIC AWARENESS

This chapter details the results pertaining to the first, second and third research questions. The extent to which the phonological, cognitive and literacy skills tested are language-universal is explored in § 6.1. A correlationary analysis in section § 6.2 investigates the cross-linguistic relationship between Phoneme Matching scores in each language and Phoneme Deletion scores in each language. Then, the average (group-level) accuracy of each item on the Phoneme Matching task is examined and low accuracy items in each language are analysed in Section § 6.3. Based on this analysis, performance on the velarised-palatalised consonantal contrasts in Irish are further examined in Section § 6.4.

6.1 Comparison of Irish and English scores on each task

This section aims to address Research Question 1:

> **Do scores for Irish-English bilinguals support the assertion that phonological and cognitive abilities (phonemic awareness, rapid automatised naming, verbal short-term memory) and literacy skills are language-universal?**

In order to investigate whether participants have a unitary proficiency in each of these skills or abilities, a sign test was conducted to establish whether there was a significant difference between scores on the Irish and English versions of the tasks that measure them.[43]. The median scores for each task, the interquartile range values and the results of the sign test are presented in Table 27 for Gaeltacht participants and Table 28 for Gaelscoil participants. These values are also presented visually in Figures 15-21 (Gaeltacht participants) and Figures 22-28 (Gaelscoil participants). Note that if the z-statistic is above +/-1.96 (equivalent to a p-value <.05), the null hypothesis (that there is no differences in the medians of the Irish and English scores) is rejected.

The assumptions of the sign test were met. These are that (i) the dependent variable is continuous (ii) there is one independent variable consisting of matched pair or related groups and (iii) the pairs of observations for each participant are independent. Separate tests were conducted for Gaeltacht and Gaelscoil participants, and results are presented below in § 6.1.1 and § 6.1.2 respectively. Note that while it is conventional to report median

[43] The significance level is calculated using the binomial test for the GT group, and by the normal approximation to the binomial distribution for the GS group, due to the larger sample size.

values with this statistical test, it is the signs (+/-) of the median differences which are analysed in this test (see § 5.8.4 for a more thorough description of the sign test).

6.1.1 Gaeltacht participants

The scores of the Gaeltacht participants are reported in Table 27 and described in this section.

Phoneme Matching. In Grade 1, participants attained a higher median score on the Irish Phoneme Matching task (mdn = 17) than on the English task (mdn = 16), though the sign test indicated that this difference is not statistically significant. In Grade 2 and 3, participants had a significantly higher median score on the English task (mdn = 18 in Grade 2; mdn = 21 in Grade 3) than on the Irish task (mdn = 17 in Grade 2; mdn = 18 in Grade 3). This indicates that although the GS participants have higher (though not significantly so) Phoneme Matching scores in Irish than in English in Grade 1, this pattern is reversed in Grade 2 and 3. The significant difference between Irish and English Phoneme Matching scores suggests that there is a language-specific aspect to this fundamentally phonological skill, and that LPA (as measured by the Phoneme Matching scores) cannot be considered to be a language-universal ability or skill in Irish-English bilinguals.

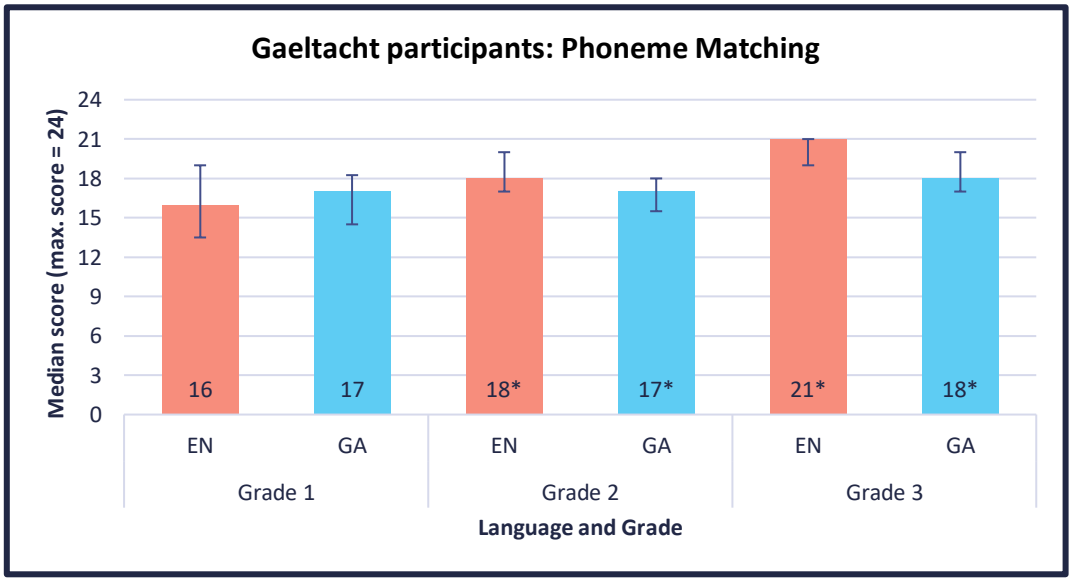

Figure 15 Gaeltacht participants: median Irish and English Phoneme Matching scores in Grade 1, 2 and 3. Median score denotes the median number of stimuli accurately identified as matching or mismatching. Note: EN = English; GA = Irish. Error bars represent interquartile range values. An asterisk beside each number in a set of values indicate that there is a statistically-significant difference between them.

Phoneme Deletion. There was no significant between Irish and English Phoneme Deletion scores in either Grade 2 or Grade 3 . In Grade 2, the median score was 9 for both versions of the task, while in Grade 3, the median score was 10 for both versions of the task. This finding suggests that MPA (as measured by Phoneme Deletion scores) is a language-universal skill in Irish and English, for which there is a common underlying proficiency.

Table 27

Gaeltacht participants: Median scores, interquartile range (IQR) and sign test statistics for differences between Irish and English tasks. Note: Z-statistic of +/- 1.96 and p=value of less than .05 indicate that there is a significant difference between scores in Irish and English. Statistically-significant values are in bold.

	Grade 1						**Grade 2**						**Grade 3**					
Task (total no. of stimuli)	**Mdn. EN**	**IQR EN**	**Mdn. GA**	**IQR GA**	**z**	**p**	**Mdn. EN**	**IQR EN**	**Mdn. GA**	**IQR GA**	**z**	**p**	**Mdn. EN**	**IQR EN**	**Mdn. GA**	**IQR GA**	**z**	**p**
Phoneme Matching (24)	16	5.5	17	3.75	.000	1.00	18	3	17	2.5	**-4.36**	**.000**	21	2	18	3	**-4.13**	**.000**
Phoneme Deletion (12)	-	-	-	-	-	-	9	9.5	9	7	.316	.754	10	4	10	4	.000	1.00
RAN Objects (n/a)	76	50	60.5	38.5	**-2.12**	**.031**	64	31	53	21	**-3.06**	**.001**	50	27	41.5	20.25	**-2.12**	**.031**
Forward Word span (8)	4	1	4	1.25	-.250	.803	5	1.5	5	1	-.250	.804	5	1	5	1.75	-.29	.774
Productive Vocabulary (45)	-	-	37	4.25	-	-	-	-	40	2	-	-	-	-	39	3.75	-	-
Letter Knowledge (10)	8	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Word Reading (20/40)	-	-	-	-	-	-	-	-	14	10	-	-	37	26	32.5	14.25	.000	1.00
Spelling (8)	-	-	-	-	-	-	-	-	-		-	-	5	4	4.5	4.75	.87	.39

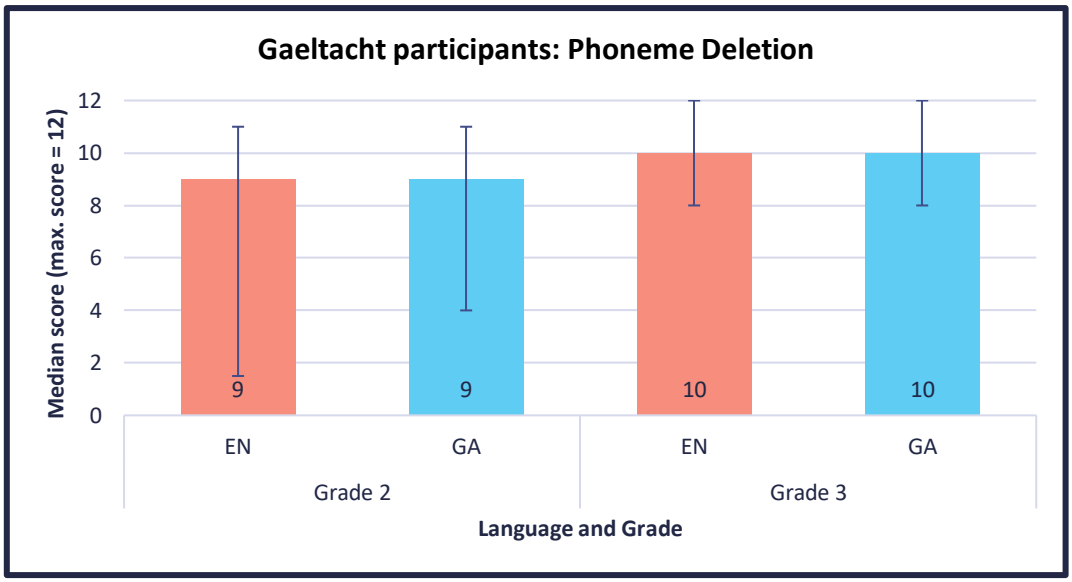

Figure 16 Gaeltacht participants: median Irish and English Phoneme Deletion scores in Grade 2 and 3. Median score denotes the median number of stimuli from which a phoneme was accurately deleted. Note: EN = English; GA = Irish. Error bars represent interquartile range values. An asterisk beside each number in a set of values indicate that there is a statistically-significant difference between them.

RAN Objects. The Irish RAN task was completed significantly faster than the English task in every grade. In Grade 1, the median time it took to complete the RAN task was 60.5 seconds for the Irish version and 76 seconds for the English version. In Grade 2, the median time it took to complete the RAN task was 53 seconds for the Irish version of the task and 64 seconds for the English version. In Grade 3, the median time it took to complete the RAN task was 41.5 seconds for the Irish version and 50 seconds for the English version. The significant difference in performance in the Irish and English version of the RAN task indicate that RAN is a language-specific skill, rather than a common underlying cognitive process across languages.

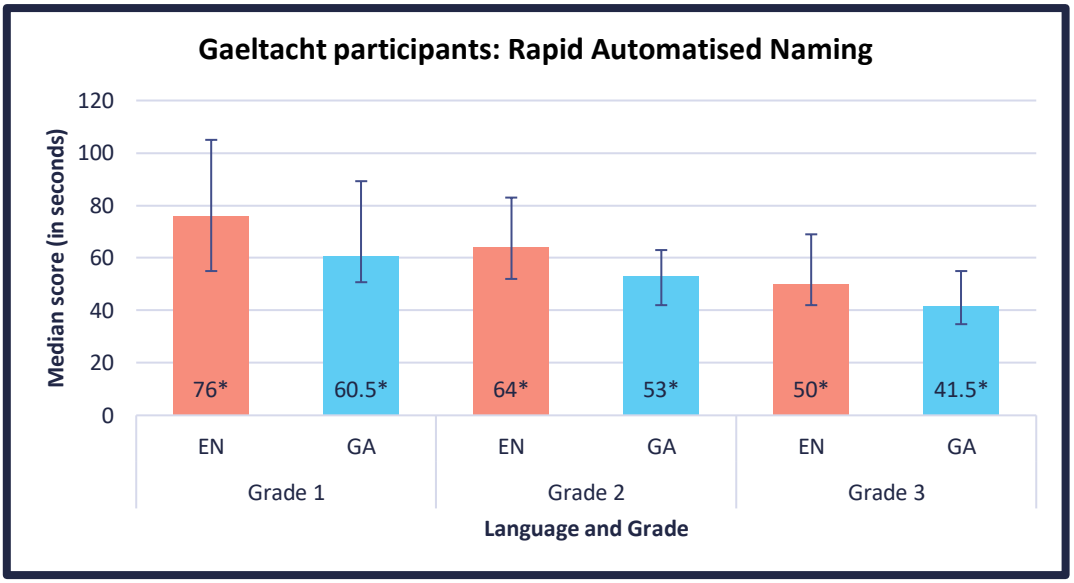

Figure 17 Gaeltacht participants: median Irish and English Rapid Automatised Naming scores (in seconds) in Grade 1, 2 and 3. Y-axis shows the median number of seconds it took participants to name 35 images of objects. Note: EN = English; GA = Irish. Error bars represent interquartile range values. An asterisk beside each number in a set of values indicate that there is a statistically-significant difference between them.

Forward Word Span task. There was no significant difference Irish and English Forward Word Span scores in any grade. The median number of words recalled was 4 in Grade 1 and 5 in Grade 2 and Grade 3. This suggests that VSTM (as measured by the Forward Word Span scores) is a language-universal skill in Irish and English, supporting the theory that VSTM is a common underlying cognitive process in Irish-English bilinguals.

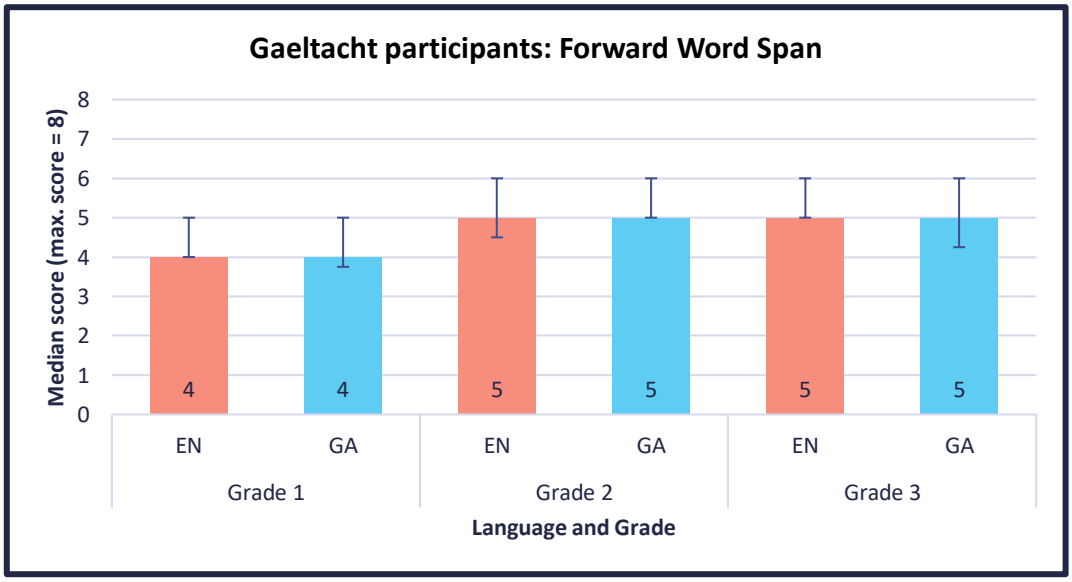

Figure 18 Gaeltacht participants: median Irish and English Forward Word Span score in Grade 1, 2 and 3. Median score denotes the median number of words which participants recalled. Note: EN = English; GA = Irish. Error bars represent interquartile range values. An asterisk beside each number in a set of values indicate that there is a statistically-significant difference between them.

Productive Vocabulary. As vocabulary was only assessed in Irish, only the raw score is presented here and a sign test is not carried out. The median productive vocabulary score was 37 in Grade 1, 40 in Grade 2 and 39 in Grade 3.

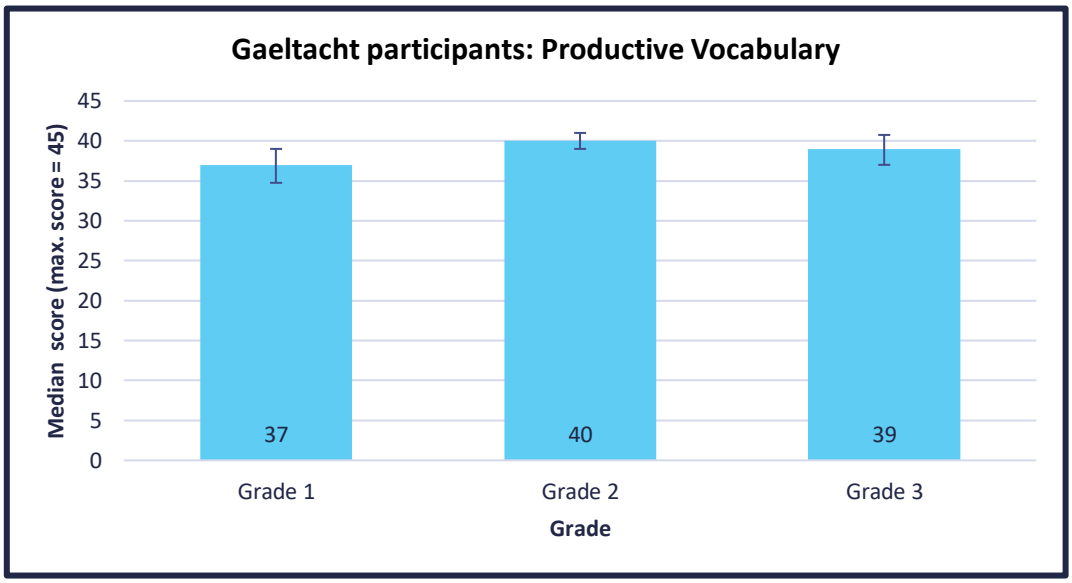

Figure 19 Gaeltacht participants: median Irish Productive Vocabulary scores in Grade 1, 2 and 3. Median score denotes the median number of images of objects which participants could name. Error bars represent interquartile range values.

Word Reading accuracy. In Grade 2, the median number of words read correctly was 14 in Irish. In Grade 3, the median number of words read accurately was 37 in English and 32.5 in Irish, though the sign test indicates that this difference is not statistically significant. The non-significant finding would suggest that there is a common underlying proficiency supporting Word Reading in each language. Note though that the interquartile range values indicate a larger amount of variation in English Word Reading accuracy than in Irish Word Reading accuracy.

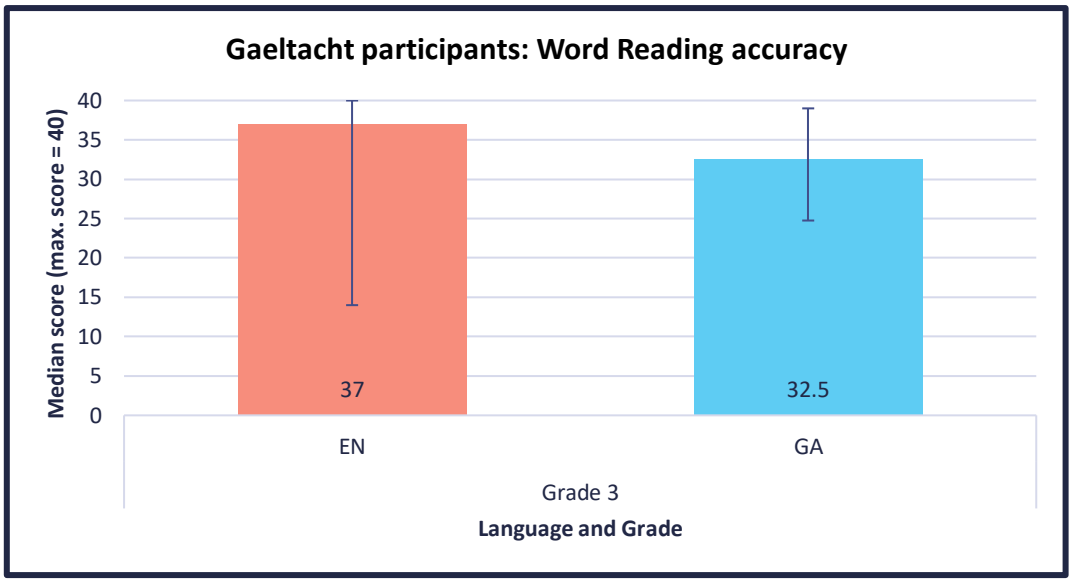

Figure 20 Gaeltacht participants: median Irish and English Word Reading accuracy scores in Grade 3. Median score denotes the median number of words which were read accurately by participants. Note: EN = English; GA = Irish. Error bars represent interquartile range values. An asterisk beside each number in a set of values indicate that there is a statistically-significant Figure difference between them.

Spelling accuracy. The median number of words spelled accurately was 5 in English and 4.5 in Irish. Again, the sign test indicates that this is not a significant difference. In keeping with the previous finding in relation to Word Reading accuracy, this suggests that Spelling is supported by a common underlying proficiency in both languages.

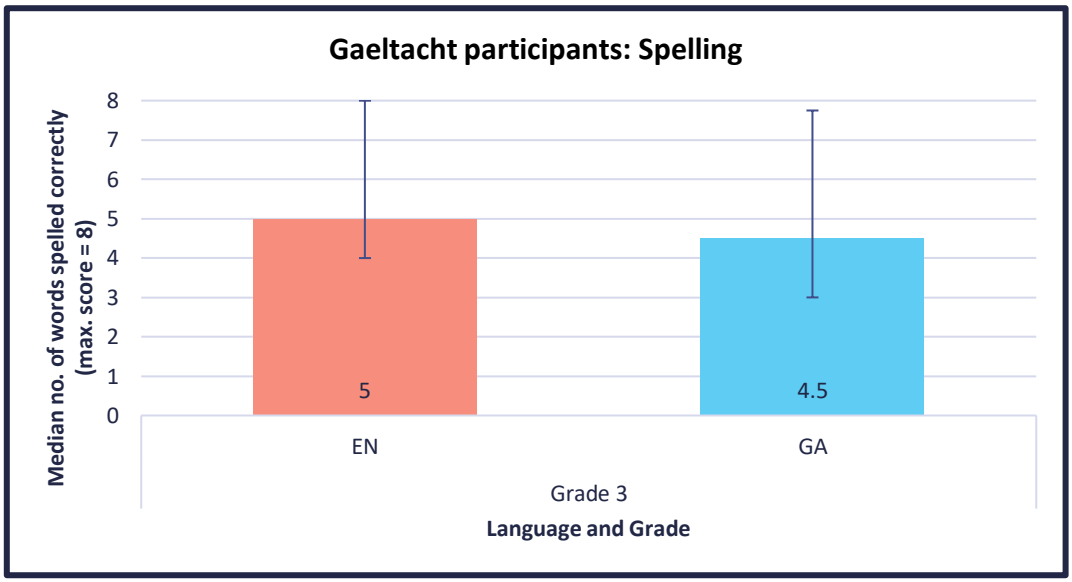

Figure 21 Gaeltacht participants: median Irish and English Spelling scores in Grade 3. Note: EN = English; GA = Irish. Error bars represent interquartile range values. An asterisk beside each number in a set of values indicate that there is a statistically-significant difference between them.

6.1.2 Gaelscoil participants

The scores of Gaelscoil pupils are reported in Table 28 and described in this section.

Phoneme Matching. Participants had significantly higher scores on the English Phoneme Matching task than on the Irish task in every grade. In Grade 1 and 2, there is a single point difference in the median score on the Irish and English version of the task (mdn = 18 vs 17; 19 vs 18, respectively). In Grade 3, the gap in median score widens to 20 in English and 18 in Irish. This mirrors the finding in relation to the GT participants, suggesting that there is a language-specific component to LPA.

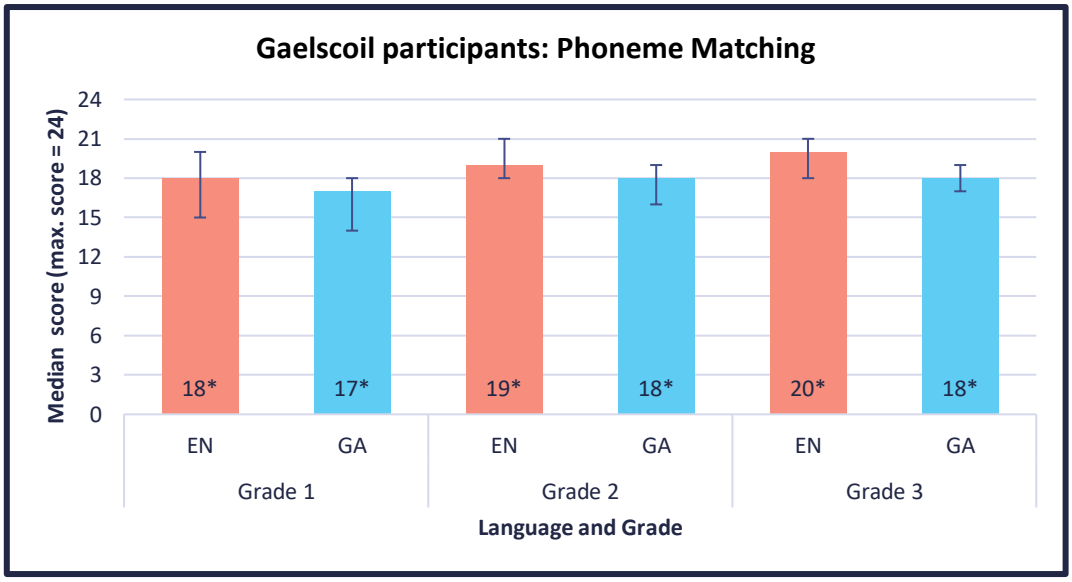

Figure 22 Gaelscoil participants: median Irish and English Phoneme Matching scores in Grade 1, 2 and 3. Median score denotes the median number of stimuli accurately identified as matching or mismatching. Note: EN = English; GA = Irish. Error bars represent interquartile range values. An asterisk beside each number in a set of values indicate that there is a statistically-significant difference between them.

Phoneme Deletion task. There was no significant difference in Phoneme Deletion scores in Grade 2 or Grade 3. Performance parallels that of the GT group: in Grade 2, the median score was 9 for both versions of the Phoneme Deletion task, while in Grade 3, the median score was 10 for both versions of the task. This is in keeping with the finding in relation to the GT participants, and supports the theory that MPA is a language-universal skill for which there is a common underlying proficiency in Irish and English.

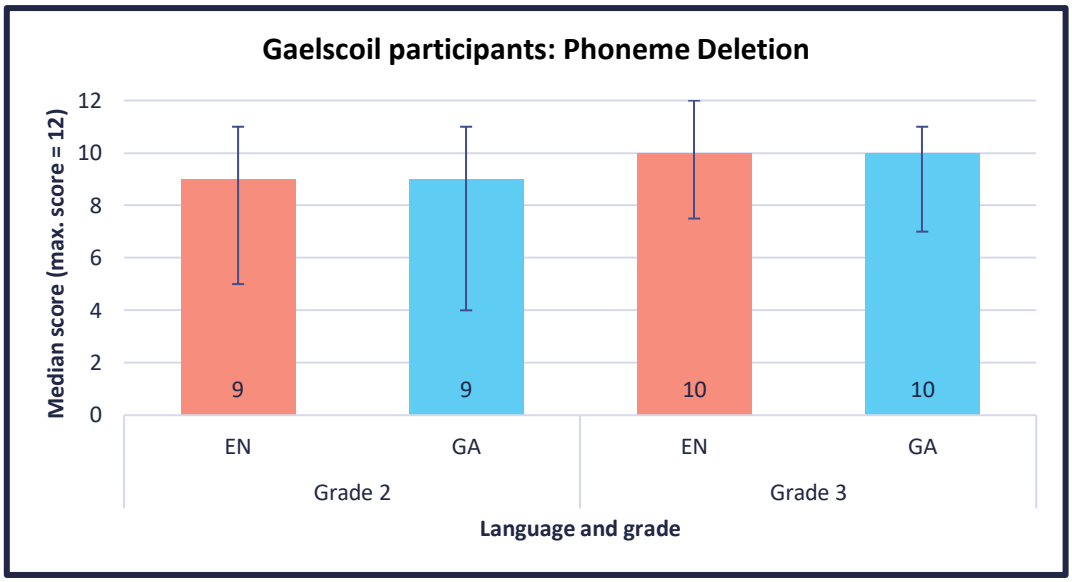

Figure 23 Gaelscoil participants: median Irish and English Phoneme Deletion scores in Grade 2 and 3. Median score denotes the median number of stimuli from which a phoneme was accurately deleted. Note: EN = English; GA = Irish. Error bars represent interquartile range values. An asterisk beside each number in a set of values indicate that there is a statistically-significant difference between them.

Table 28

Gaelscoil participants: Median scores, interquartile range (IQR) and sign test statistics for differences between Irish and English tasks. Note: Z-statistic of +/- 1.96 and p=value of less than .05 indicate that there is a significant difference between scores in Irish and English. Statistically-significant values are in bold.

	Grade 1						Grade 2						Grade 3					
Task (total no. of items)	**Mdn. EN**	**IQR EN**	**Mdn. GA**	**IQR GA**	**z**	**p**	**Mdn. EN**	**IQR EN**	**Mdn. GA**	**IQR GA**	**z**	**p**	**Mdn. EN**	**IQR EN**	**Mdn. GA**	**IQR GA**	**z**	**p**
Phoneme Matching (24)	18	5	17	4	**-3.98**	**.000**	19	3	18	3	**-9.39**	**.000**	20	3	18	2	**-10.1**	**.000**
Phoneme Deletion (12)	-	-	-	-	-	-	9	6	9	7	.120	.905	10	4.5	10	4	-.71	.476
RAN Objects (n/a)	57	23	75	34	**5.48**	**.000**	49	20	55.5	24.25	**3.36**	**.001**	45	15.5	54	19	**5.91**	**.000**
Forward Word span (8)	5	2	5	2	**-2.23**	**.026**	5	1.25	5	2	-1.44	.149	6	2	6	2.25	-1.72	.085
Productive Vocabulary (45)	-	-	34	5	-	-	-	-	37	5.5	-	-	-	-	36	6	-	-
Letter Knowledge (10)	-	-	8	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Word Reading (20/40)	-	-	-	-	-	-	-	-	10	11.25	-	-	25	27	25	23.5	1.87	.062
Spelling (8)	-	-	-	-	-	-	-	-	-	-	-	-	4		4		-.67	.505

RAN Objects. In direct contrast to the GT group, the English RAN task was completed significantly faster than the Irish version in every grade. In Grade 1, the median time it took to complete the RAN task was 57 seconds for the English version and 75 seconds for the Irish version. In Grade 2, the median time it took to complete the RAN task was 49 seconds for the English version of the task and 55.5 seconds for the Irish version. In Grade 3, the median time it took to complete the RAN task was 45 seconds for the English version and 54 seconds for the Irish version. This is in keeping with the finding in relation to GT participants, and suggests that RAN is a language-specific, rather than a common cognitive process in each language and is significantly stronger in a person's dominant language.

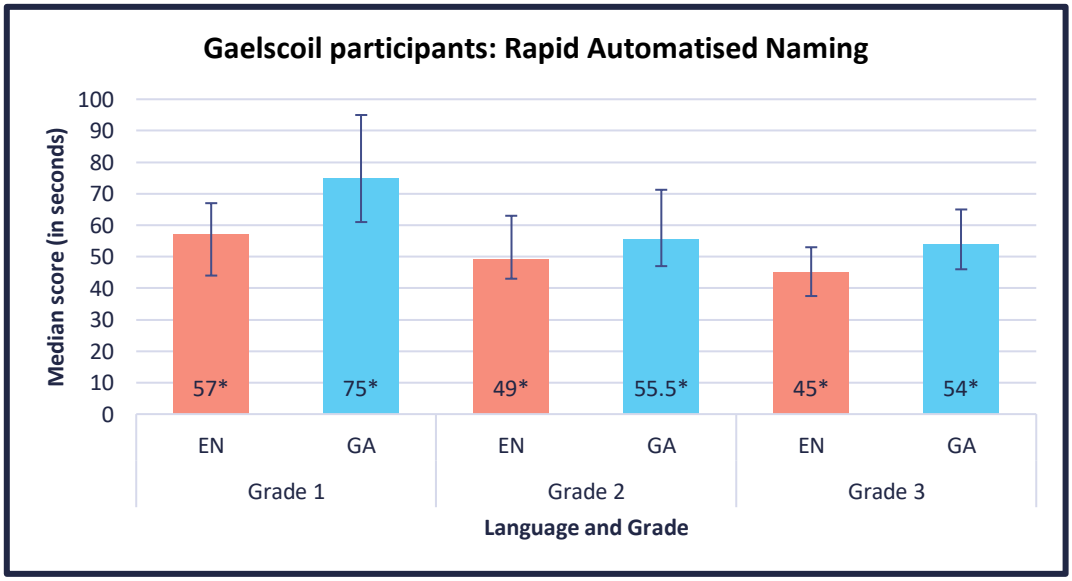

Figure 24 Gaelscoil participants: median Irish and English Rapid Automatised Naming scores (in seconds) in Grade 1, 2 and 3. Y-axis shows the median number of seconds it took participants to name 35 images of objects. Note: EN = English; GA = Irish. Error bars represent interquartile range values. An asterisk beside each number in a set of values indicate that there is a statistically-significant difference between them.

Forward Word Span. The median number of words recalled on the Forward Word Span task was 5 in Grade 1 and 6 in Grade 2 and Grade 3. Though there was no difference in the median scores, the sign test indicates a statistically significant difference in scores on the Irish and English versions of the task in Grade 1 (in favour of English), but not in Grade 2 or Grade 3. This finding contrasts with that of the GT group in Grade 1, but not in Grade 2 or 3, and may suggest that verbal short-term memory is a common cognitive process in each language when a relatively low threshold of language-learning is achieved.

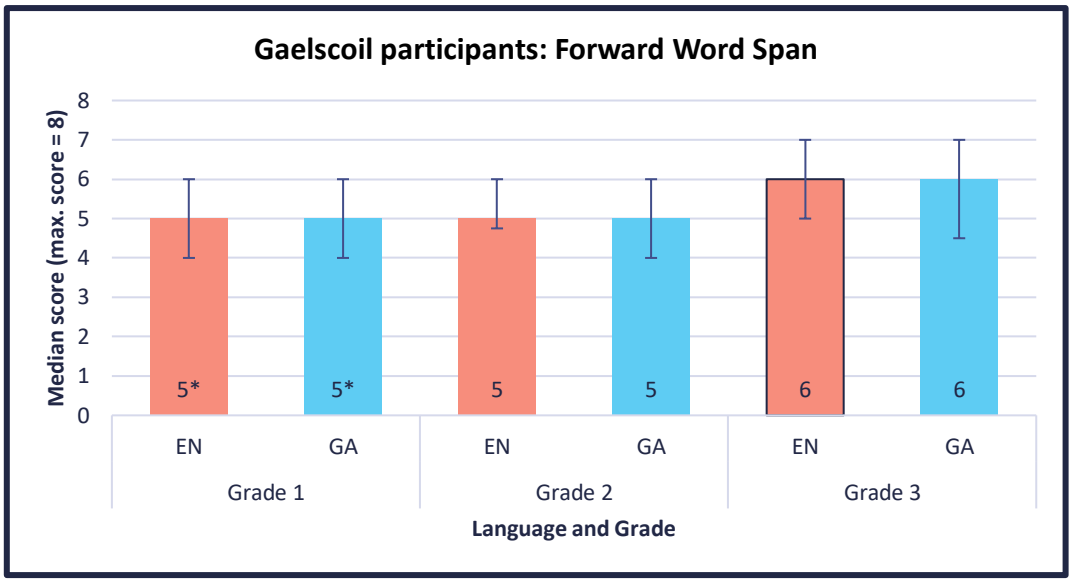

Figure 25 Gaelscoil participants: median Irish and English Forward Word Span scores in Grade 1, 2 and 3. Median score denotes the median number of words which participants recalled. Note: EN = English; GA = Irish. Error bars represent interquartile range values. An asterisk beside each number in a set of values indicate that there is a statistically-significant difference between them.

Productive Vocabulary. As vocabulary was only assessed in Irish, only the raw score is presented here and a sign test is not carried out. The median productive vocabulary score was 37 in Grade 1, 40 in Grade 2 and 39 in Grade 3.

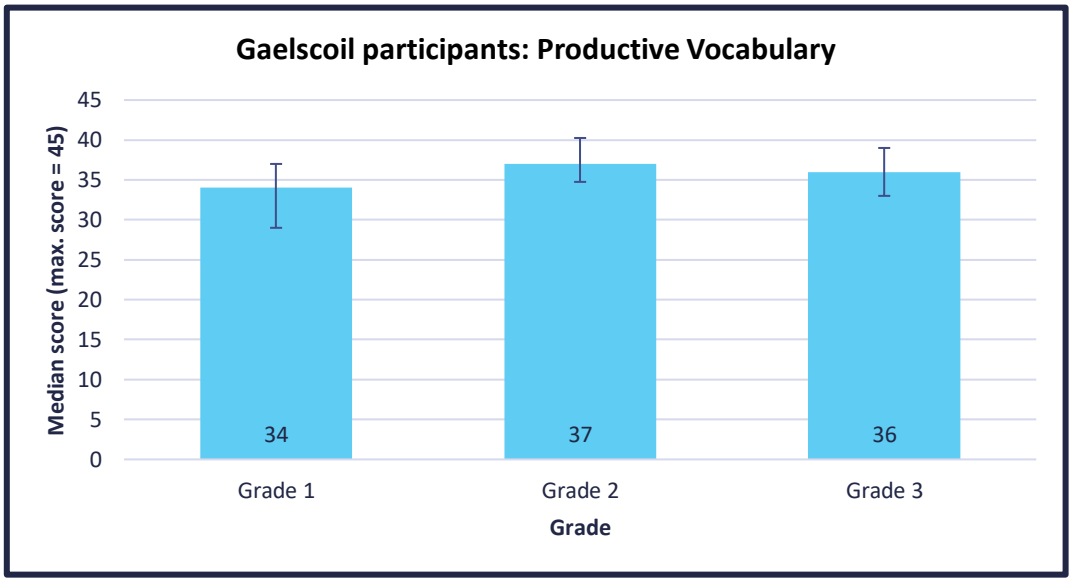

Figure 26 Gaelscoil participants: median Irish Productive Vocabulary scores in Grade 1, 2 and 3. Median score denotes the median number of images of objects which participants could name. Note: Error bars represent interquartile range values.

Word Reading accuracy. In Grade 2, the median number of words read accurately in Irish was 10. In Grade 3, the median number of words read accurately was 25 in both English in Irish. The sign test indicates that there is no significant difference between Irish and English Word Reading scores: this suggests that there is a common underlying proficiency supported Word Reading accuracy in each language.

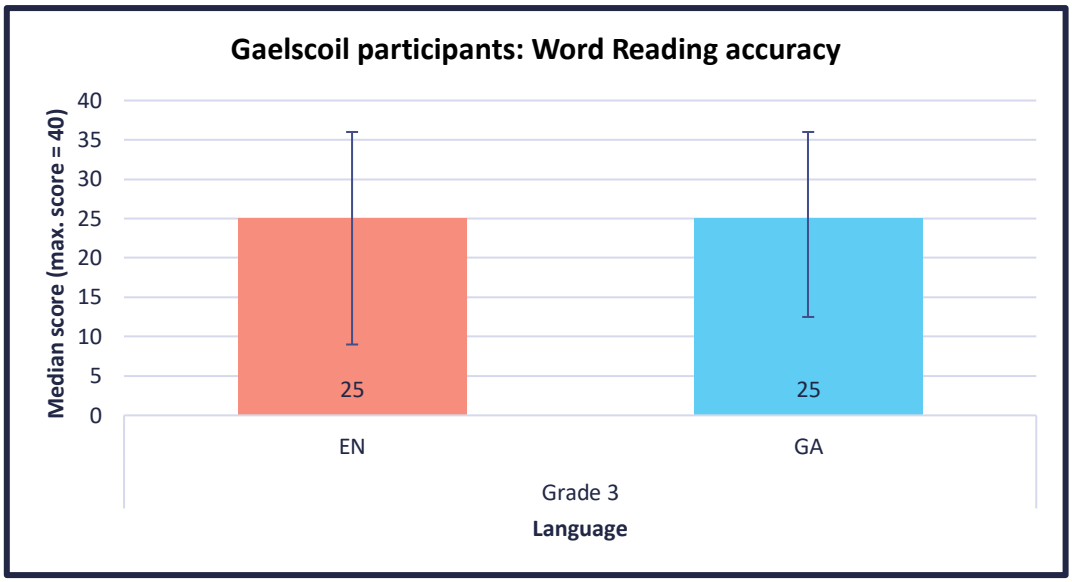

Figure 27 Gaelscoil participants: median Irish and English Word Reading accuracy scores in Grade 3. Median score denotes the median number of words which were read accurately by participants. Note: EN = English; GA = Irish. Error bars represent interquartile range values. An asterisk beside each number in a set of values indicate that there is a statistically-significant difference between them.

Spelling. The sign test indicates that there is no difference in Spelling scores in Irish and English: the median number of words spelled accurately was 4 in English and 4 in Irish. This finding indicates that there is a common underlying proficiency supporting Spelling in each language.

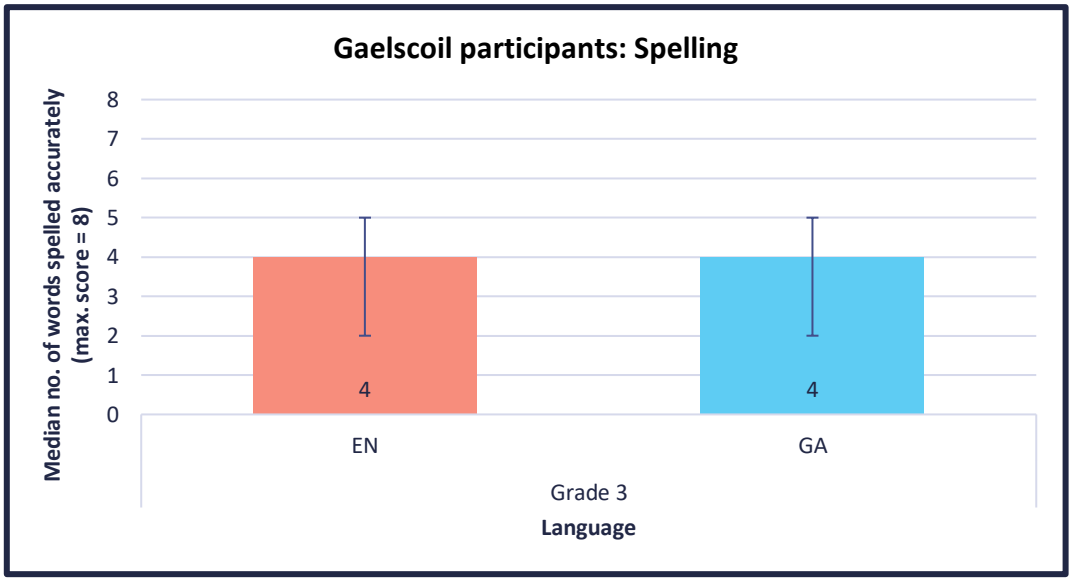

Figure 28 Gaelscoil participants: median Irish and English Spelling scores in Grade 3. Median score denotes the median number of words which were spelled accurately by participants. Note: EN = English; GA = Irish. Error bars represent interquartile range values. An asterisk beside each number in a set of values indicate that there is a statistically-significant difference between them.

6.1.3 Descriptive summary of sign test results

Table 29 provides a descriptive summary of the sign test results.

Table 29

Summary table: sign test results. Note: cells highlighted in orange denote significantly better performance in English than in Irish; cells highlighted in blue denote significantly better performance in Irish than in English. Cells which are not highlighted indicate that there was no significant difference between the Irish and English version of the task.

	Gaeltacht participants			Gaelscoil participants		
	Grade 1	**Grade 2**	**Grade 3**	**Grade 1**	**Grade 2**	**Grade 3**
Phoneme Matching	No significant difference	English > Irish	English > Irish	English > Irish	English > Irish	English > Irish
Phoneme Deletion	-	No significant difference	No significant difference	-	No significant difference	No significant difference
RAN Objects	Irish > English	Irish > English	Irish > English	English > Irish	English > Irish	English > Irish
Forward Word Span	No significant difference	No significant difference	No significant difference	English > Irish	No significant difference	No significant difference
Word Reading	-	-	No significant difference	-	-	No significant difference
Spelling	-	-	No significant difference	-	-	No significant difference

There is a notable difference between the two tasks measuring phonemic awareness in terms of their sign test results; it appears that while MPA (as measured by Phoneme Deletion scores) is an area of common underlying proficiency in both languages, LPA (as measured by Phoneme Matching scores) is at least partially language-specific. This matter is explored further in § 6.4, where it is established that the velarised-palatalised consonant contrasts are the primary source of this cross-linguistic difference. There are also mixed findings in relation to scores on cognitive tasks. There is ample evidence to suggest that RAN is a language-specific ability and a distinct cognitive process in each language. Though the evidence suggests that VSTM (as measured by Forward Word Span scores) is a common cognitive process across languages, the significant difference between Irish and English scores in Grade 1 GT participants may indicate that a certain threshold of language learning must be achieved to allow for this. With regard to the literacy domain, it appears that Word Reading and Spelling are supported by a common underlying proficiency in each of a bilingual's languages.

6.2 Correlationary analysis: phonemic awareness within and across languages

The aim of this section is to investigate Research Question 2:

To what extent can metalinguistic phonemic awareness and linguistic phonemic awareness be considered the same construct (i) within languages and (ii) across languages?

A correlational analysis is presented in order to investigate this research question. The relationship between Phoneme Matching scores across languages (i.e. Phoneme Matching in Irish and English) and the relationship between Phoneme Deletion scores across languages is of interest in the present study as it provides an indication of the extent to which these abilities are language-universal.

In addition, the correlation between Phoneme Deletion scores and Phoneme Matching scores within a language (e.g. Irish Phoneme Matching and Irish Phoneme Deletion) indicates the extent to which these tasks measure two elements of a single construct within a language. Pearson's correlations are presented in Table 30 in order to investigate the aforementioned correlations. Note that this data relates to an aggregate sample of Grade 2 and Grade 3 (GS and GT participants; n = 240)

Though there is not a consensus on the interpretation of correlation coefficients, the conventional approach to interpretation (Schober, 2018) is adopted in this analysis:

0.00 – 0.10	Negligible correlation
0.10 – 0.39	Weak correlation
0.40 – 0.69	Moderate correlation
0.70 – 0.89	Strong correlation
0.90 – 1.00	Very strong correlation

Table 30

*Correlation matrix: Phoneme Matching and Phoneme Deletion scores. Note:**Correlation is significant at the 0.01 level (2-tailed).*

	Irish Phoneme Matching	English Phoneme Matching	Irish Phoneme Deletion	English Phoneme Deletion
Irish Phoneme Matching	1	.52**	.39**	.38**
English Phoneme Matching	.52**	1	.36**	.39**
Irish Phoneme Deletion	.39**	.36**	1	.84**
English Phoneme Deletion	.38**	.39**	.84**	1

6.2.1 Within-language phonemic awareness: the relationship between Phoneme Matching scores and Phoneme Deletion scores within each language

There is a weak positive correlation between Phoneme Matching scores and Phoneme Deletion scores in Irish (r =.39, p <.001; Figure 29), and a weak positive correlation between Phoneme Matching scores and Phoneme Deletion scores in English (r =.38, p <.001; Figure 30). This indicates that there is a similar relationship between LPA and MPA in each language. The weak correlation suggests that these constructs are separable from one another, though they are both within the phonological domain.

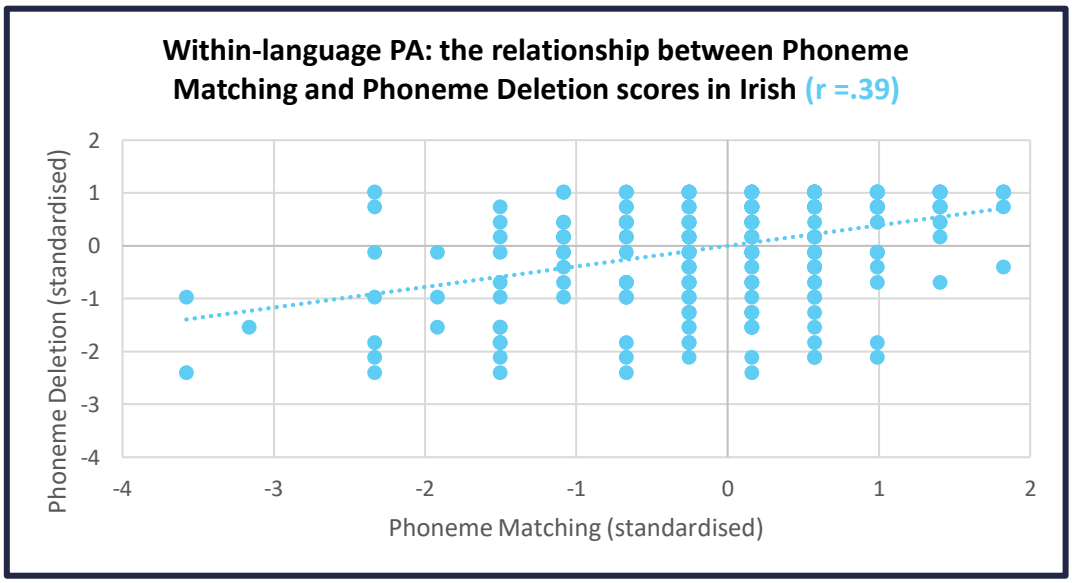

Figure 29 Scatterplot: the relationship between Phoneme Matching scores and Phoneme Deletion scores in Irish

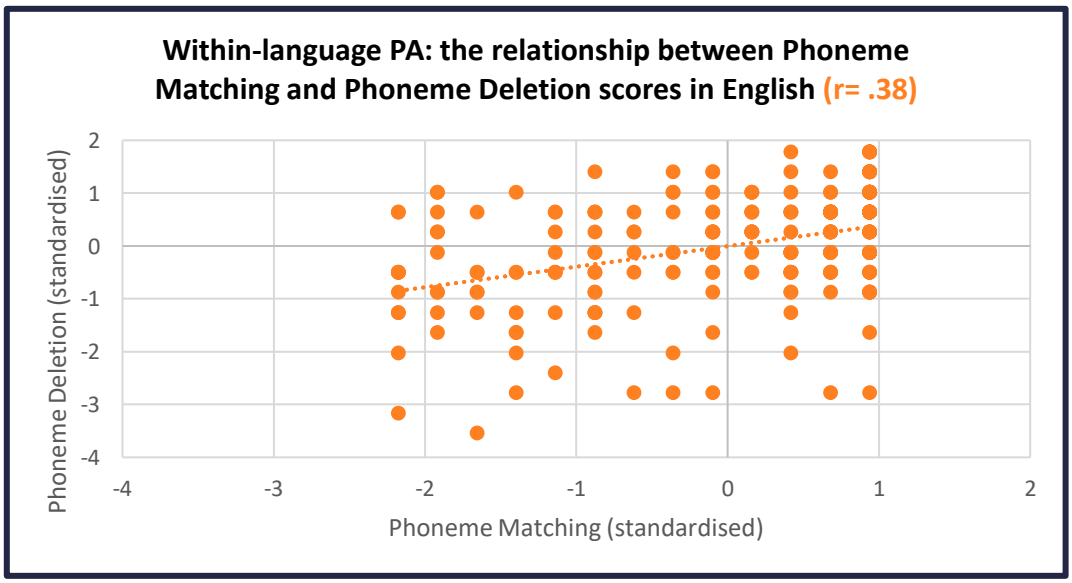

Figure 30 Scatterplot: the relationship between Phoneme Matching scores and Phoneme Deletion scores in English

6.2.2 Cross-linguistic phonemic awareness: the relationship between Phoneme Matching scores and Phoneme Deletion scores in Irish and English

There is a moderate positive correlation between Phoneme Matching scores in Irish and English (r = .52, p <.001; Figure 31), and a strong positive correlation between Phoneme Deletion scores in Irish and English (r =.84, p <.001; Figure 32). This indicates that MPA (as measured by Phoneme Deletion scores) is a more unitary construct across these two languages than is LPA (measured by Phoneme Matching scores), which has a larger language-specific component.

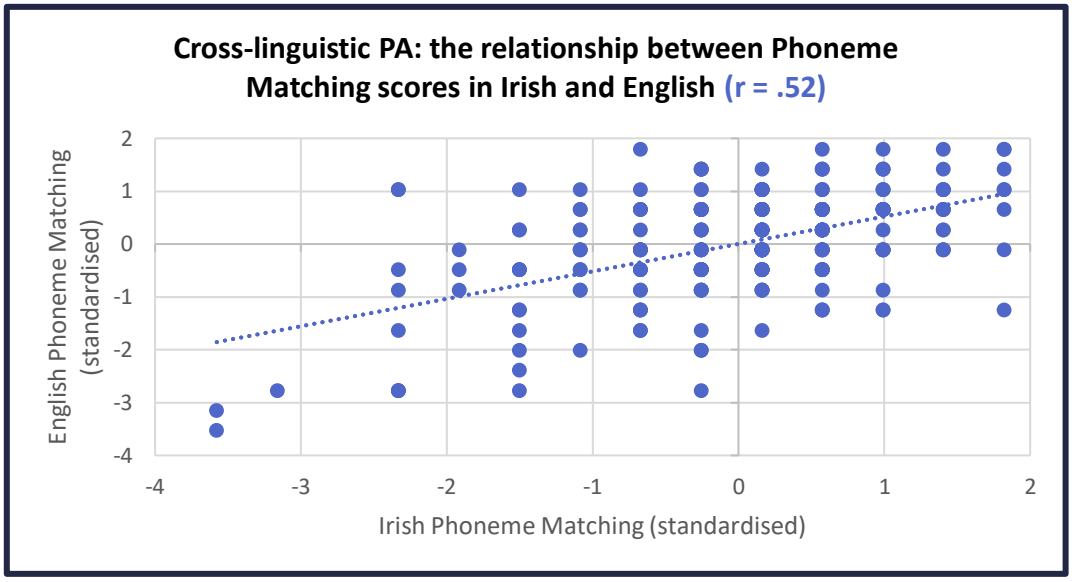

Figure 31 Scatterplot: the relationship between Phoneme Matching scores in Irish and English

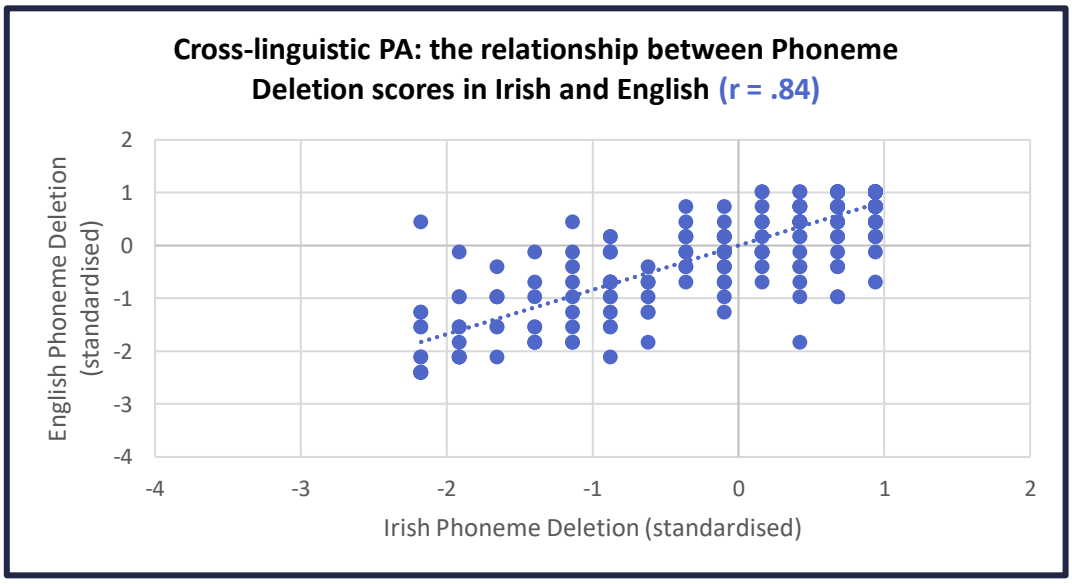

Figure 32 Scatterplot: the relationship between Phoneme Deletion scores in Irish and English

6.2.3 Summary

The results indicate that while there is a strong correlation between Phoneme Deletion scores across languages, there is a moderate correlation between Phoneme Matching scores across languages. This suggests that MPA is a more unitary construct across languages than LPA is. This is in line with the findings of § 6.1 which indicated that there was a significant difference between Phoneme Matching scores in Irish and English for both GS and GT participants, however there was not a significant difference between Phoneme Deletion scores in Irish and English in either group. The results also indicate a weak correlation between Phoneme Matching scores and Phoneme Deletion scores within a language. This suggests that LPA (as measured by Phoneme Matching scores) and MPA (as measured by Phoneme Deletion scores) are separable constructs.

6.3 Phoneme Matching: average (group-level) accuracy per item

Given the language-specific nature of linguistic phonemic awareness, the average (group-level) accuracy of each item on the Phoneme Matching tasks is examined in this section in order to investigate which phonemic contrasts posed a difficulty for participants in Irish and English. The aim of this section is to answer Research Question 3:

> **Which phonemic contrasts are typically identified inaccurately in Irish-English bilinguals**?

The average (group-level) accuracy of each item on this task is illustrated in Figures 33 – 38 (Irish Phoneme Matching), and in Figures 41 – 46 (English Phoneme Matching.)

Low accuracy items on the Irish Phoneme Matching task are examined in § 6.3.1, while low accuracy items on the English Phoneme Matching task are examined in § 6.3.2. Low accuracy items are defined here as items on which average group-level accuracy was below the level of random chance (<50%) .

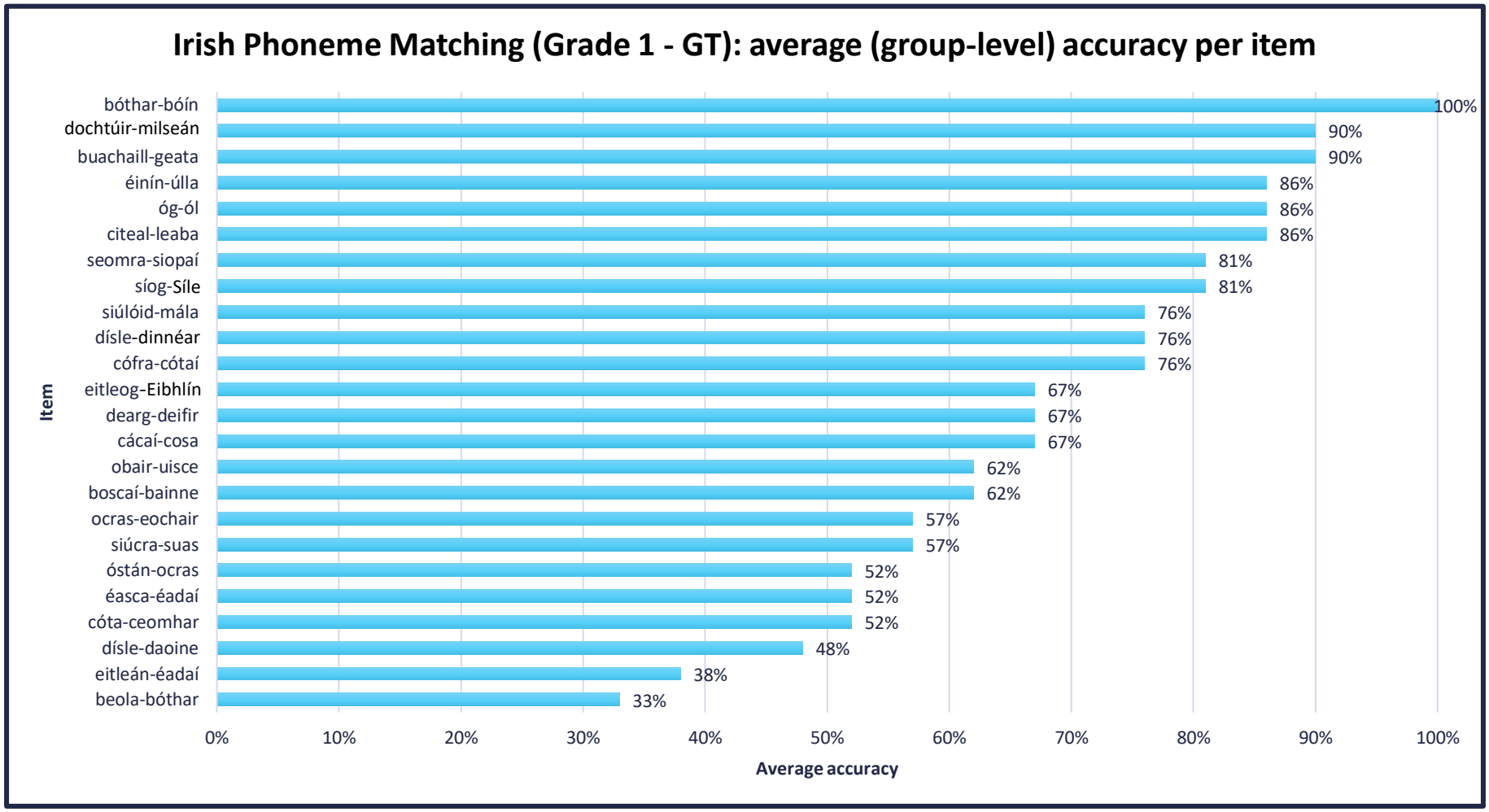

Figure 33 Grade 1 Gaeltacht participants: average (group-level) accuracy per item on the Irish Phoneme Matching task

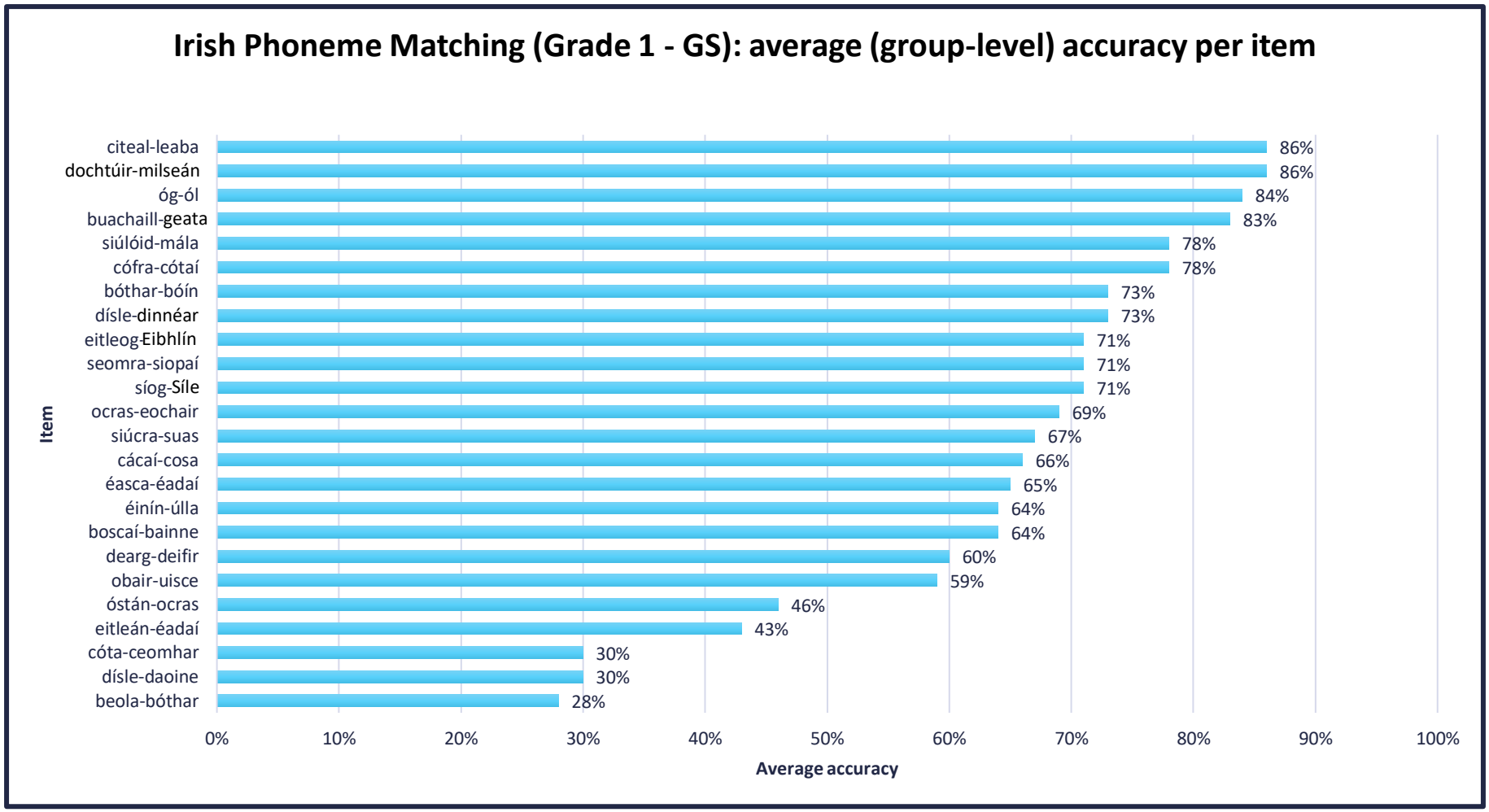

Figure 34 Grade 1 Gaelscoil participants: average (group-level) accuracy per item on the Irish Phoneme Matching task

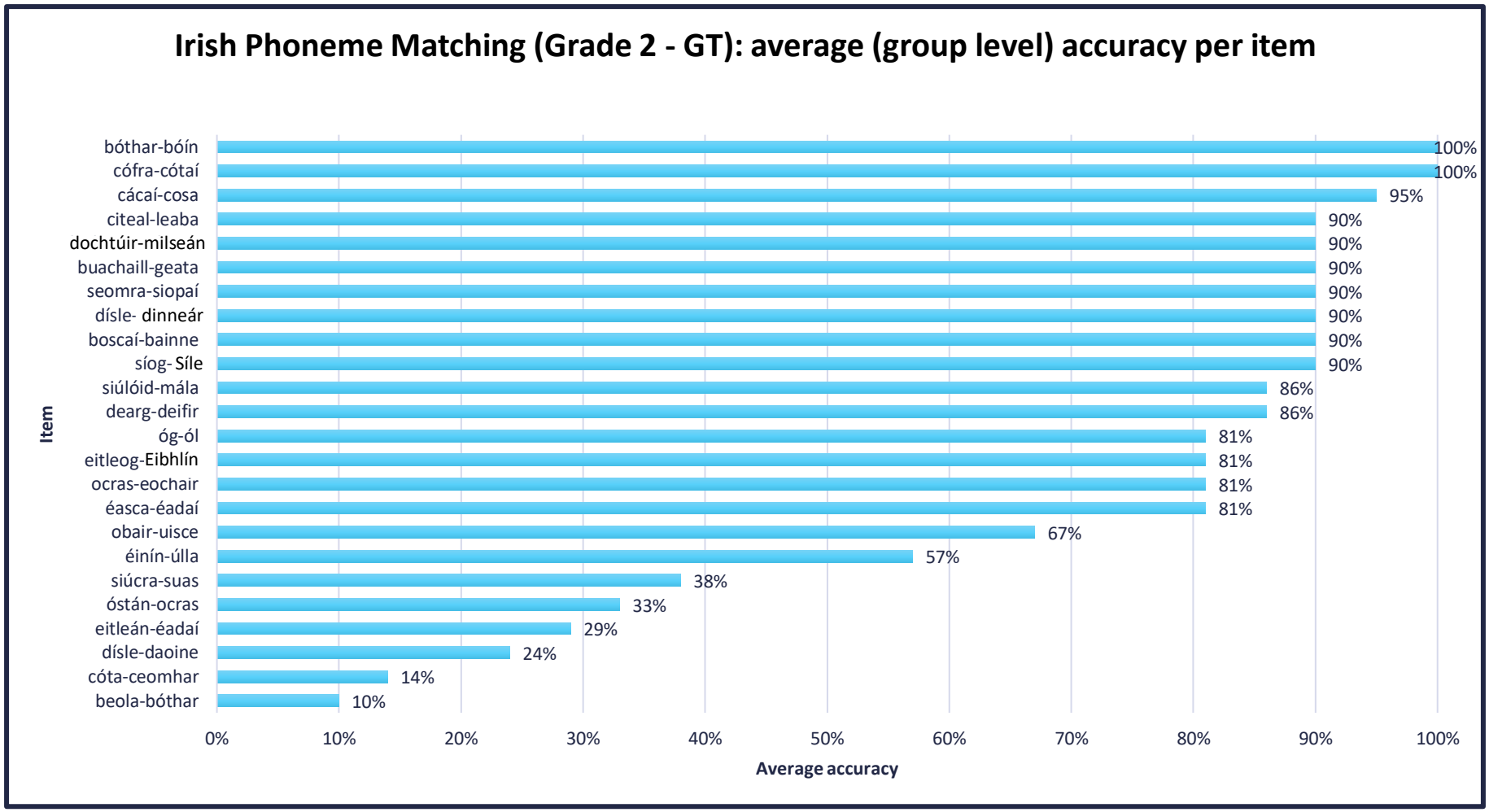

Figure 35 Grade 2 Gaeltacht participants: average (group-level) accuracy per item on the Irish Phoneme Matching task

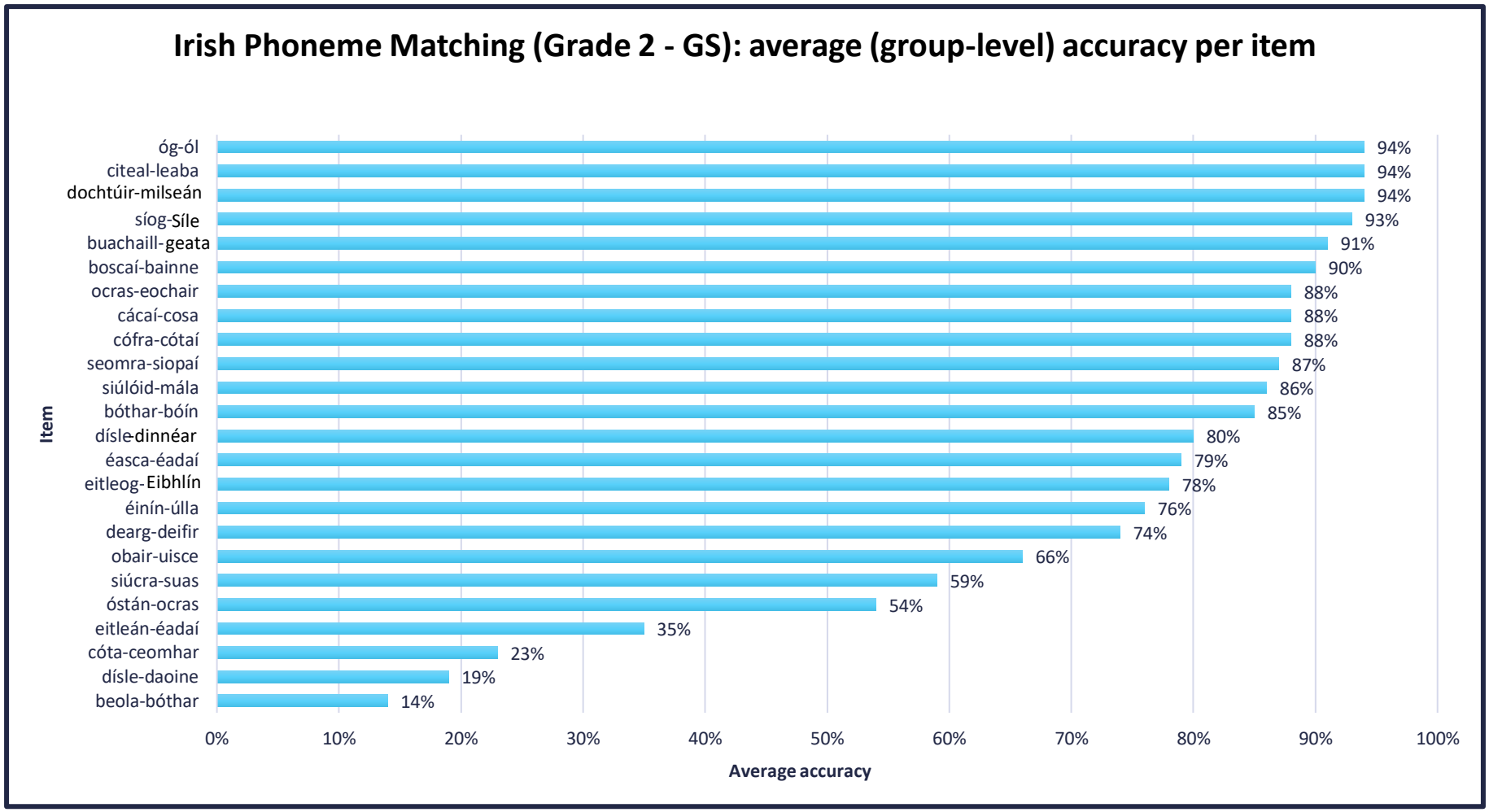

Figure 36 Grade 2 Gaelscoil participants: average (group-level) accuracy per item on the Irish Phoneme Matching task

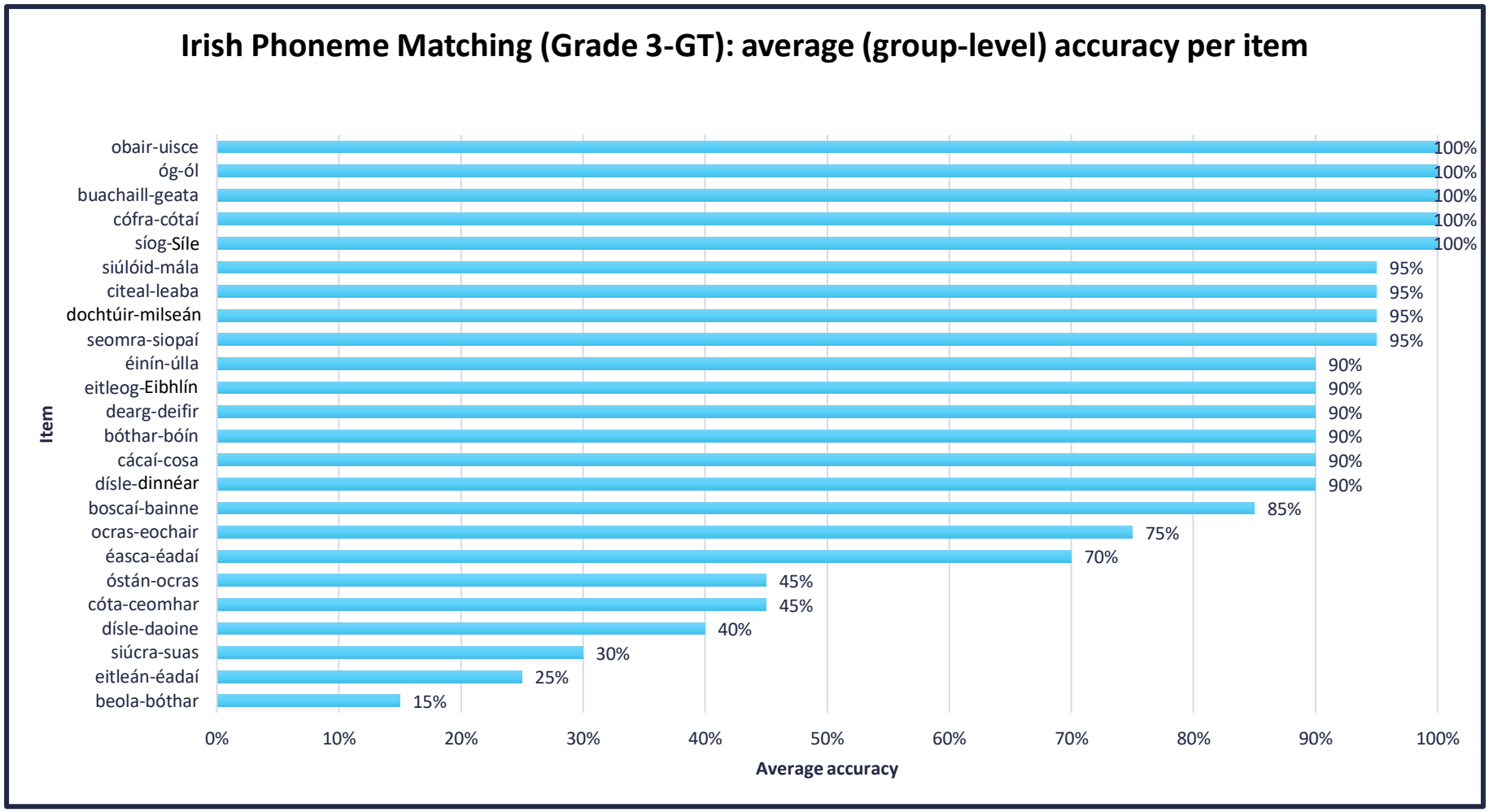

Figure 37 Grade 3 Gaeltacht participants: average (group-level) accuracy per item on the Irish Phoneme Matching task

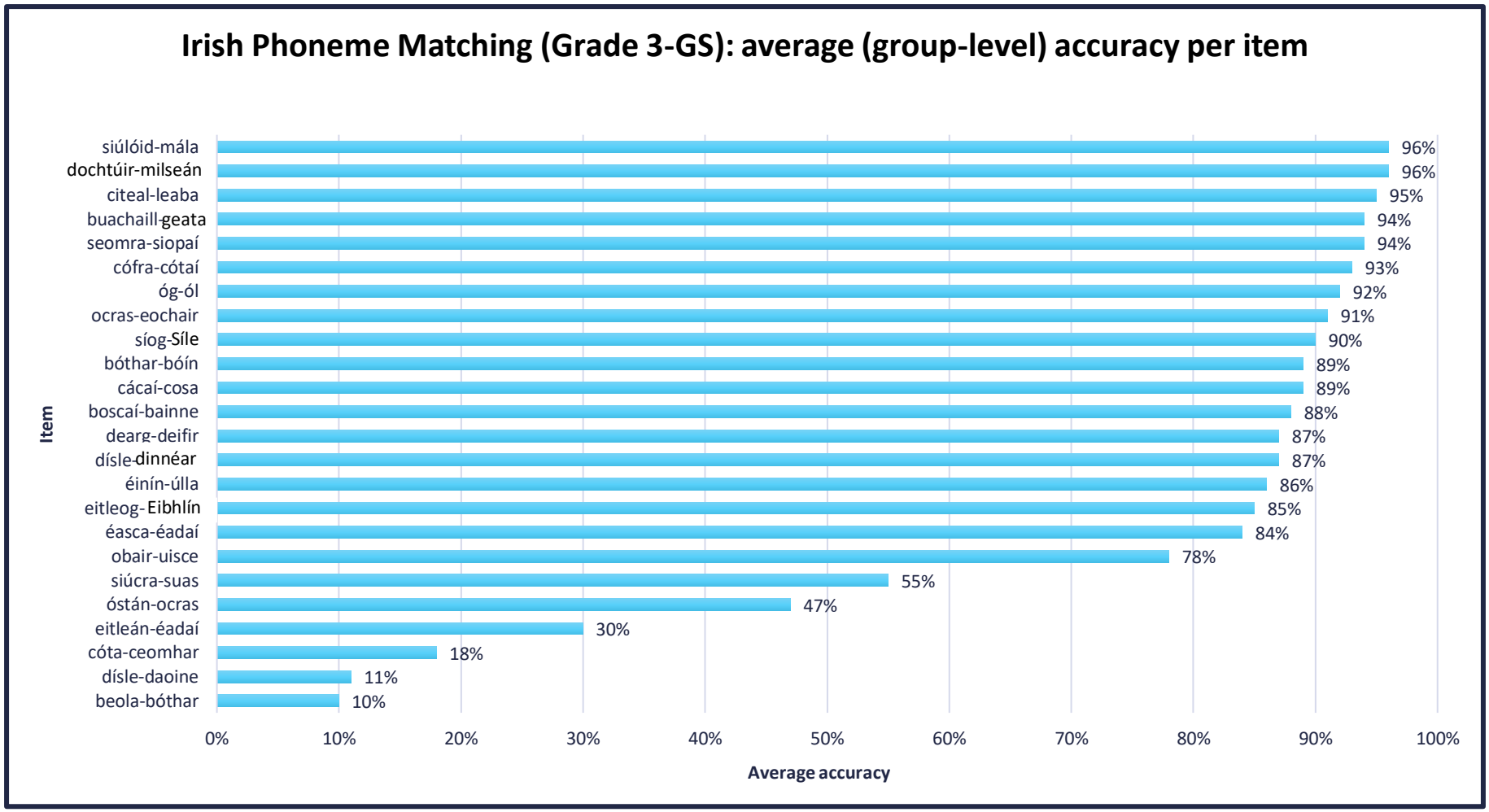

Figure 38 Grade 3 Gaelscoil participants: average (group-level) accuracy per item on the Irish Phoneme Matching task

6.3.1 Low average accuracy items at the group level: Irish Phoneme Matching

Low average accuracy items are examined in this section to investigate which phonological units in Irish posed a difficulty for participants.

Gaeltacht participants. In Grade 1, there were three low accuracy items, all of which are mismatching stimuli. Two of these are the velarised-palatalised consonant contrasts (/dʲ/-/dˠ/ and /bʲ/-/bˠ/)) and one was a long-short vowel contrast (/ɛ/-/e:/). In Grade 2 and Grade 3, six items had below 50% accuracy; all of them mismatching items. Four of these were velarised-palatalised vowel contrasts (/bʲ/-/bˠ/, /dʲ/-/dˠ/, /kˠ/-/cʲ/, /ʃʲ/-/sˠ/) and two were long-short vowel contrasts (/ɛ/-/e:/ and /ʌ/-/o:/). The group-level average accuracy values are provided in Table 31.

Table 31
Gaeltacht participants: Irish Phoneme Matching items with below 50% average accuracy

Grade 1		Grade 2		Grade 3	
33%	beola-bóthar /bʲ/-/bˠ/	**10%**	beola-bóthar /bʲ/-/bˠ/	**15%**	beola-bóthar /bʲ/-/bˠ/
38%	eitleán-éadaí /ɛ/-/e:/	**14%**	cóta-ceomhar /kˠ/-/cʲ/	**25%**	eitleán-éadaí /ɛ/-/e:/
48%	dísle-daoine /dʲ/-/dˠ/	**24%**	dísle-daoine /dʲ/-/dˠ/	**30%**	siúcra-suas /ʃ/-/s/
		29%	eitleán-éadaí /ɛ/-/e:/	**40%**	dísle-daoine /dʲ/-/dˠ/
		33%	óstán-ocras /o:/-/ʌ/	**45%**	cóta-ceomhar /kˠ/-/cʲ/
		38%	siúcra-suas /ʃʲ/-/sˠ/	**45%**	óstán-ocras /o:/-/ʌ/

Figure 39 plots the average accuracy of each item which had lower than 50% average (group-level) accuracy in any of the grades. There is evidence of a U-shaped trajectory[44] in relation to three of the velarised-palatalised consonant contrasts (/bʲ/-/bˠ/, (/dʲ/-/dˠ/, /kˠ/-/cʲ/,) as well as for one of the long-short vowel contrasts (/ʌ/-/o:/). In contrast, there is a downward trajectory for the velarised-palatalised contrast /ʃʲ/-/sˠ/ and for the vowel contrast (/ɛ/ and /e:/).

[44] Trajectory is used here though it is emphasised that this cross-sectional study cannot track longitudinal trajectory of individual participants. Instead, it is intended to show highlight the differences between group accuracy levels at differnt age-groups.

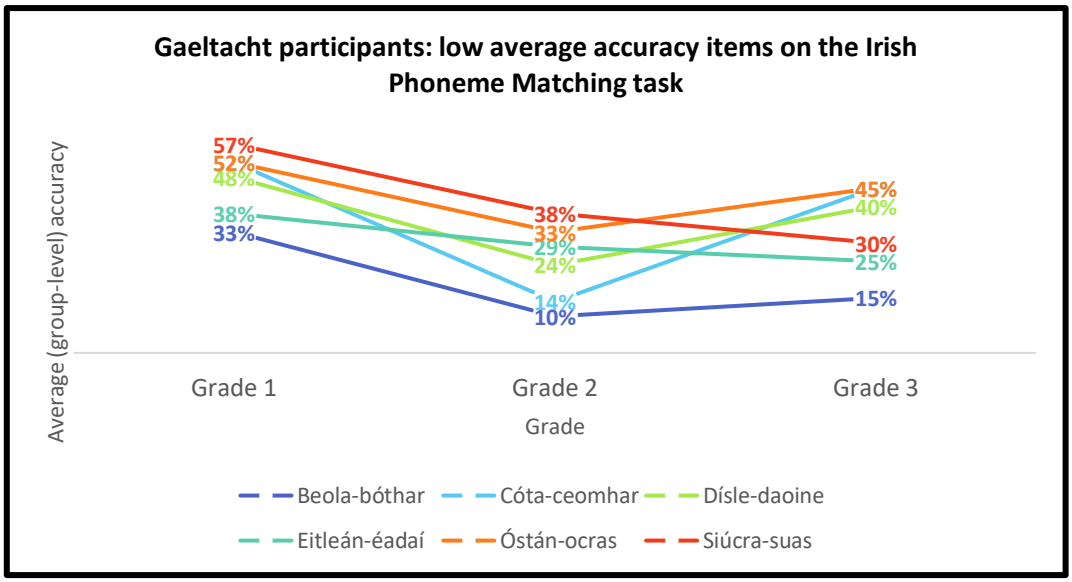

Figure 39 Gaeltacht participants: low average accuracy items on the Irish Phoneme Matching task. Low average accuracy items are pairs with less than 50% average accuracy at the group level in any grade.

Gaelscoil participants. In Grade 1 and Grade 3, there were five low average accuracy items, all of them mismatching stimuli. Three of these were the velarised-palatalised consonant contrasts (/bʲ/-bˠ/, /dʲ/- /dˠ/, /kˠ/-/cʲ/,) and two were the long-short vowel contrasts (/ɛ/-/eː/, /ʌ/-/oː/). In Grade 2, four stimuli had below 50% accuracy. Three of these were velarised-palatalised consonant contrasts (/bʲ/-bˠ/, /dʲ/- /dˠ/, /kˠ/-/cʲ/,) and one was a long-short vowel contrast (/ɛ/-/eː/,). The group-level average accuracy values are provided in Table 32.

Table 32
Gaelscoil participants: Irish Phoneme Matching items below 50% average (group-level) accuracy.

Grade 1		Grade 2		Grade 3	
28%	beola-bóthar /bʲ/-/bˠ/	**14%**	beola-bóthar /bʲ/-/bˠ/	**10%**	beola-bóthar /bʲ/-/bˠ/
30%	dísle-daoine /dʲ/-/dˠ/	**19%**	dísle-daoine /dʲ/-/dˠ/	**11%**	dísle-daoine /dʲ/-/dˠ/
30%	cóta-ceomhar /kˠ/-/cʲ/	**23%**	cóta-ceomhar /kˠ/-/cʲ/	**18%**	cóta-ceomhar /kˠ/-/cʲ/
43%	eitleán-éadaí /ɛ/-/eː/	**35%**	eitleán-éadaí /ɛ/-/eː/	**30%**	eitleán-éadaí /ɛ/-/eː/
46%	óstán-ocras /oː/-/ʌ/			**47%**	óstán-ocras /oː/-/ʌ/

Figure 40 plots the average (group-level) accuracy of each item which had lower than 50% average accuracy in any of the grades. Note that *siúcra-suas* (/ʃʲ/-/sˠ/) is included in this

chart for comparative purposes as it was a low accuracy item in the GT group. There is evidence of a downward trajectory for all of the velarised-palatalised consonant contrasts, as well as for the vowel contrast /ɛ/-/e:/. In contrast, the vowel contrast óstán-ocras /ʌ/-/o:/ has an inverted U trajectory.

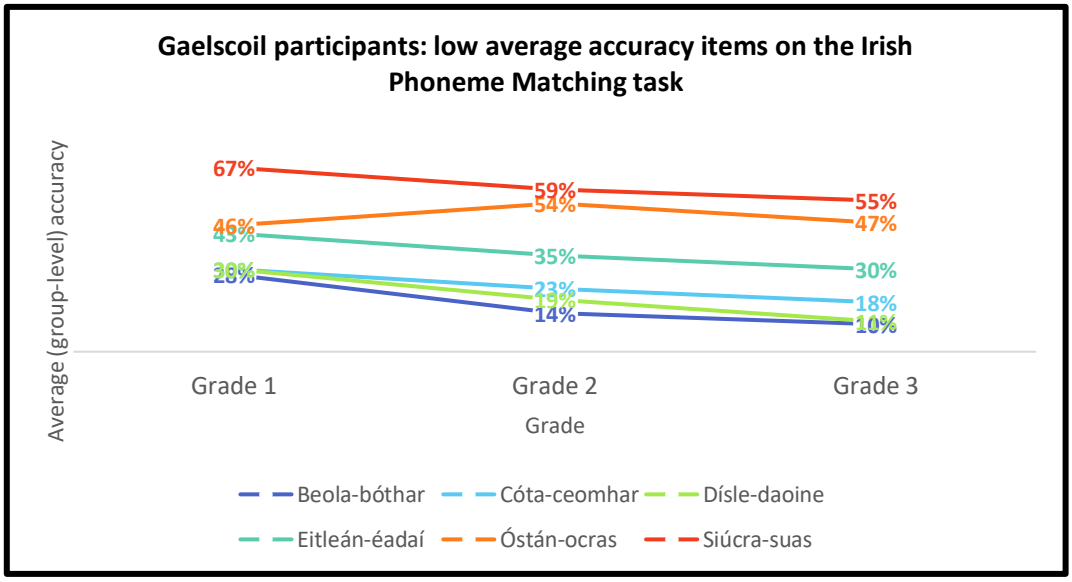

Figure 40 Gaelscoil participants: low average accuracy items on the Irish Phoneme Matching task. Low accuracy items are pairs with less than 50% average accuracy at the group level in any grade. Note that the siúcra-suas pair were not a low accuracy item in the GS group; this pair is plotted for comparability as it was a low accuracy item in the GT group (see Figure 39).

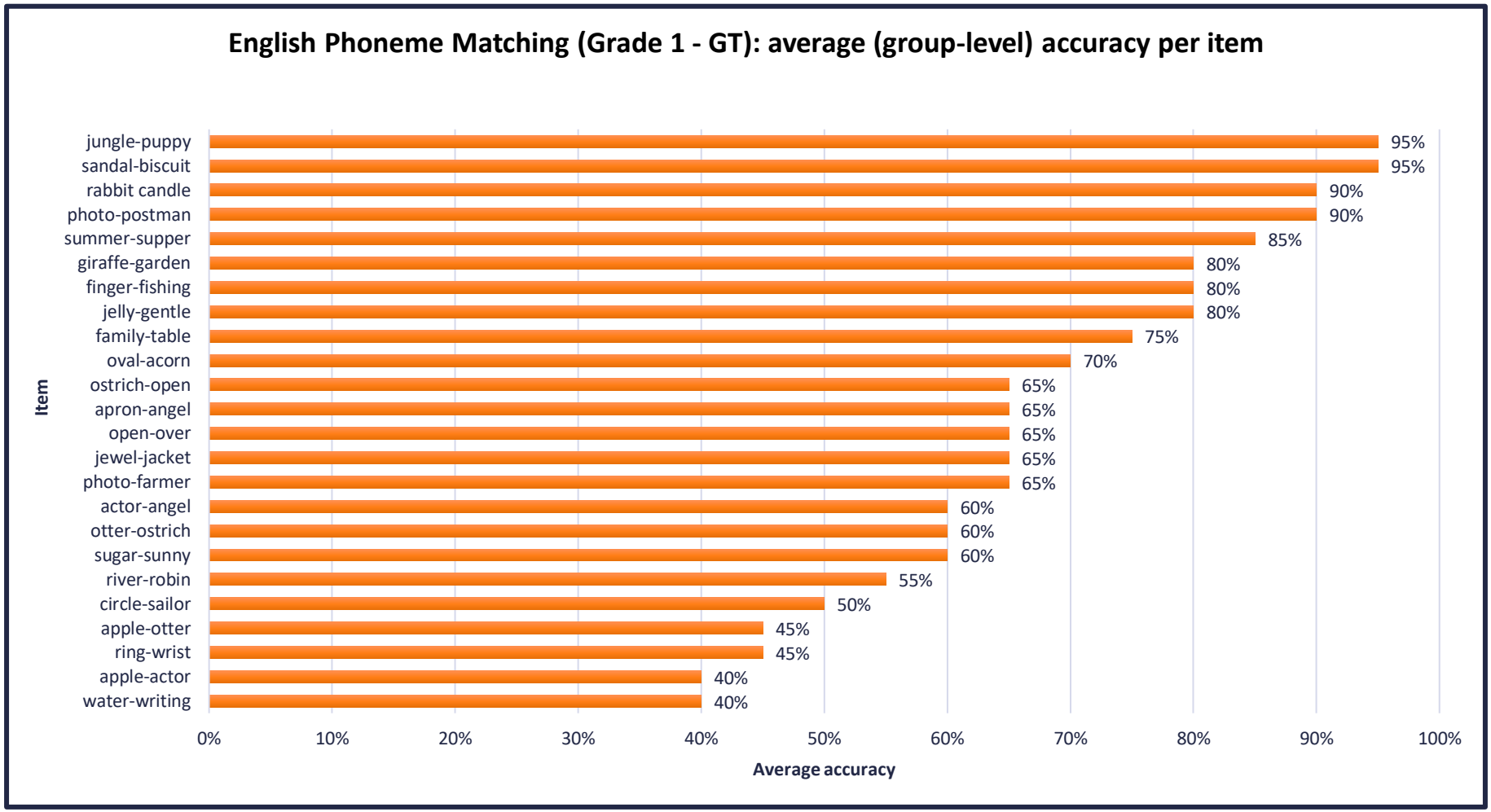

Figure 41 Grade 1 Gaeltacht participants: average (group-level) accuracy per item in the English Phoneme Matching task

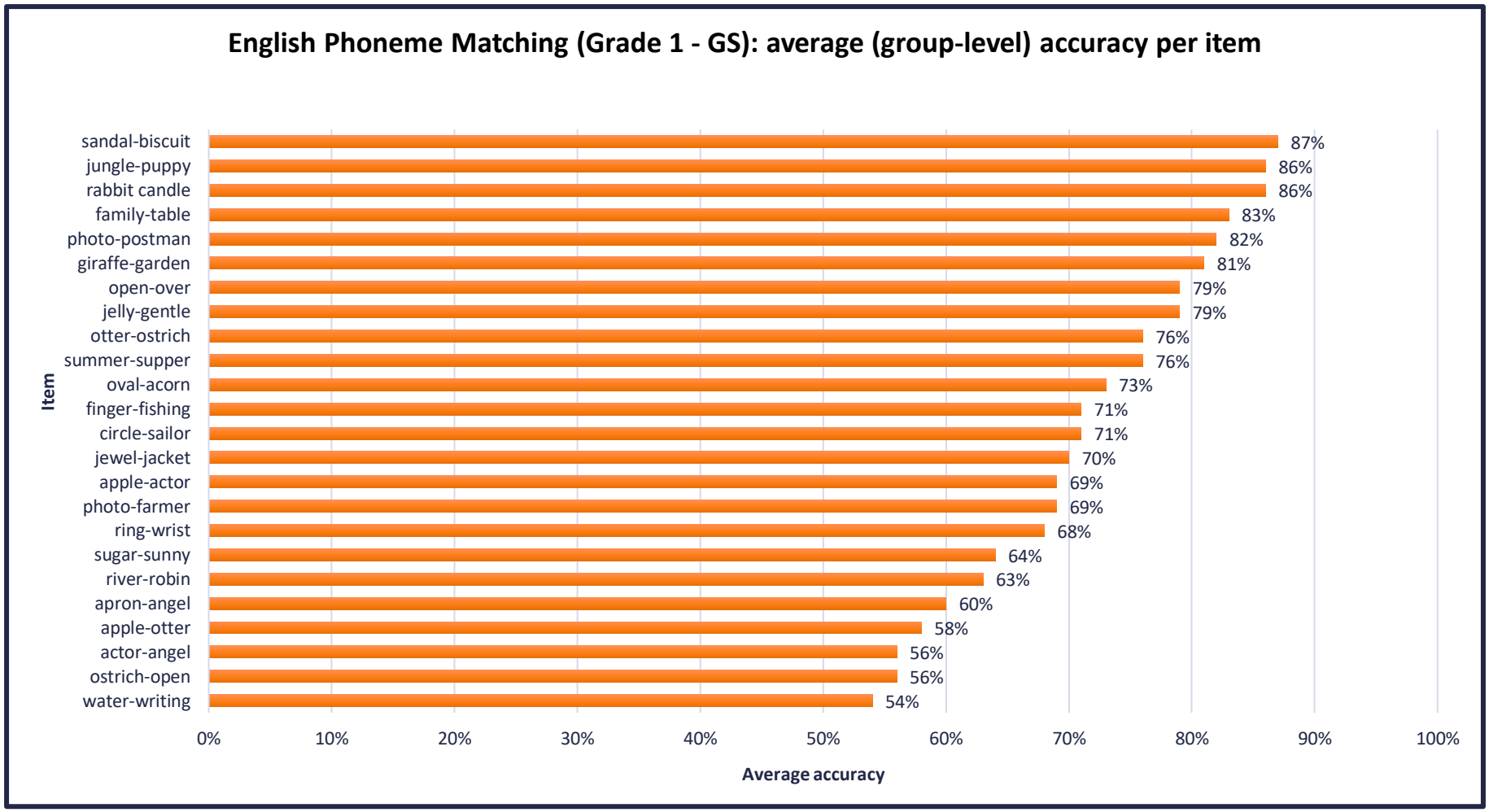

Figure 42 Grade 1 Gaelscoil participants: average (group-level) accuracy per item in the English Phoneme Matching task

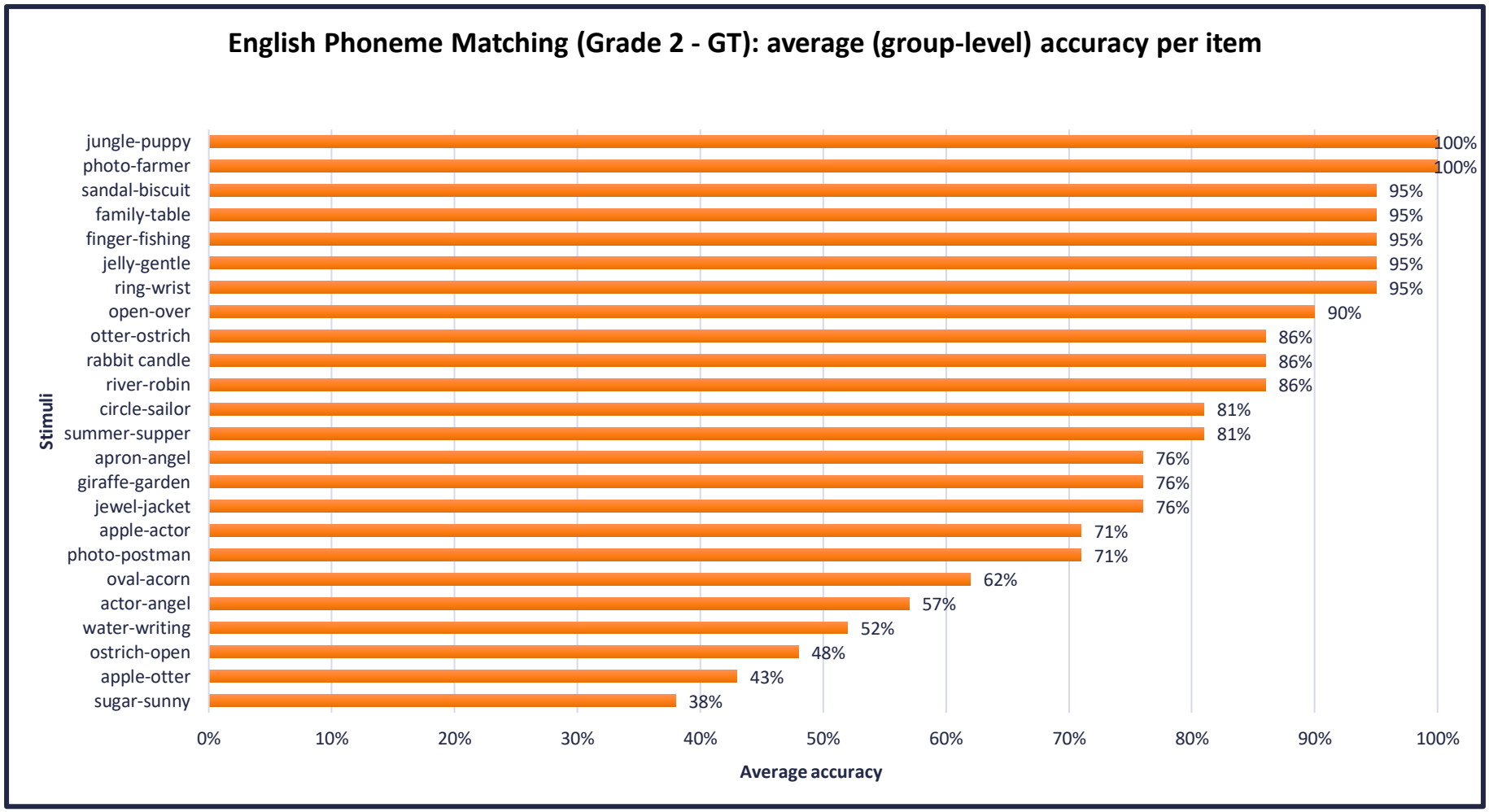

Figure 43 Grade 2 Gaeltacht participants: average (group-level) accuracy per item in the English Phoneme Matching task

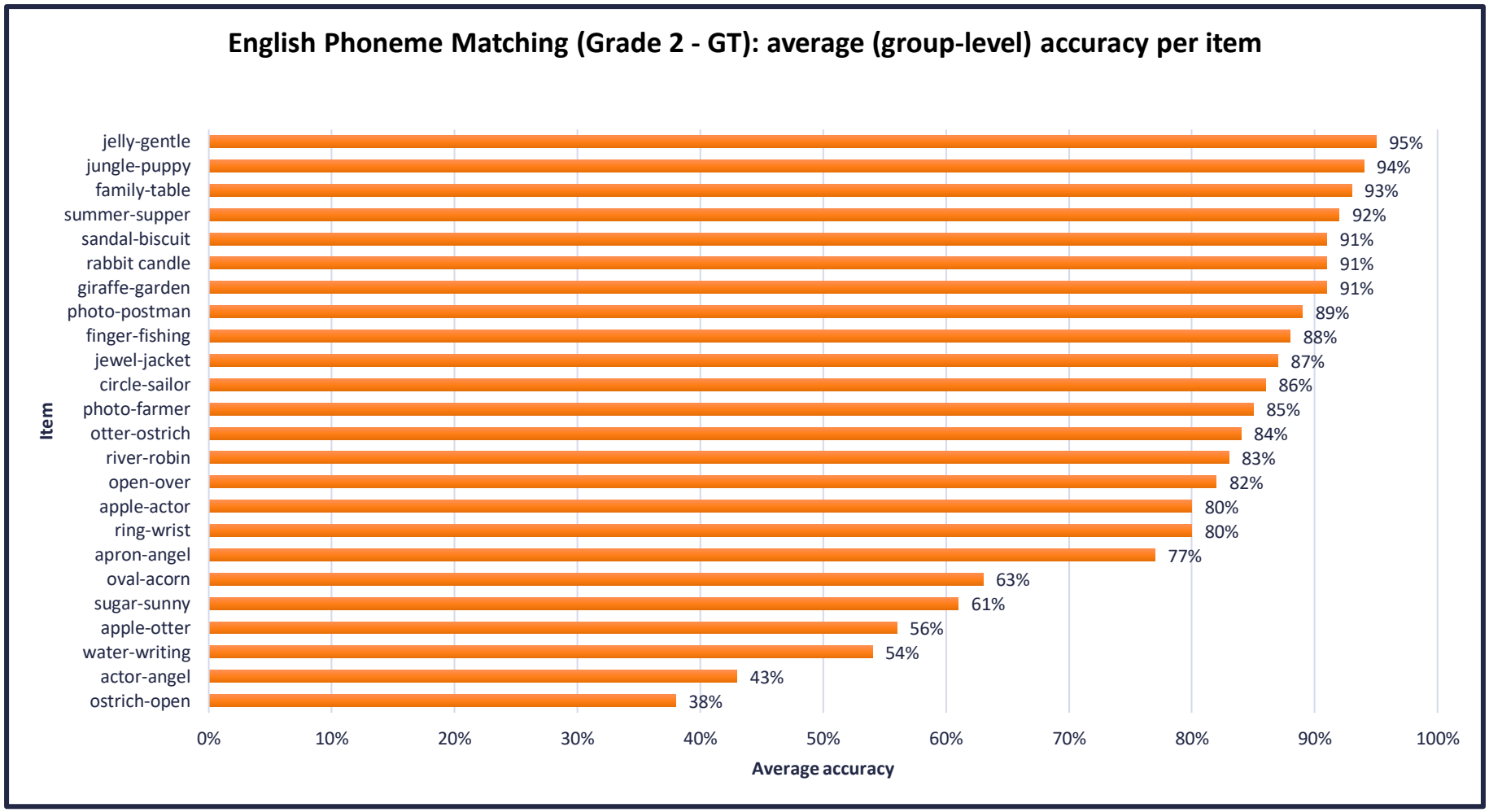

Figure 44 Grade 2 Gaelscoil participants: average (group-level) accuracy per item in the English Phoneme Matching task

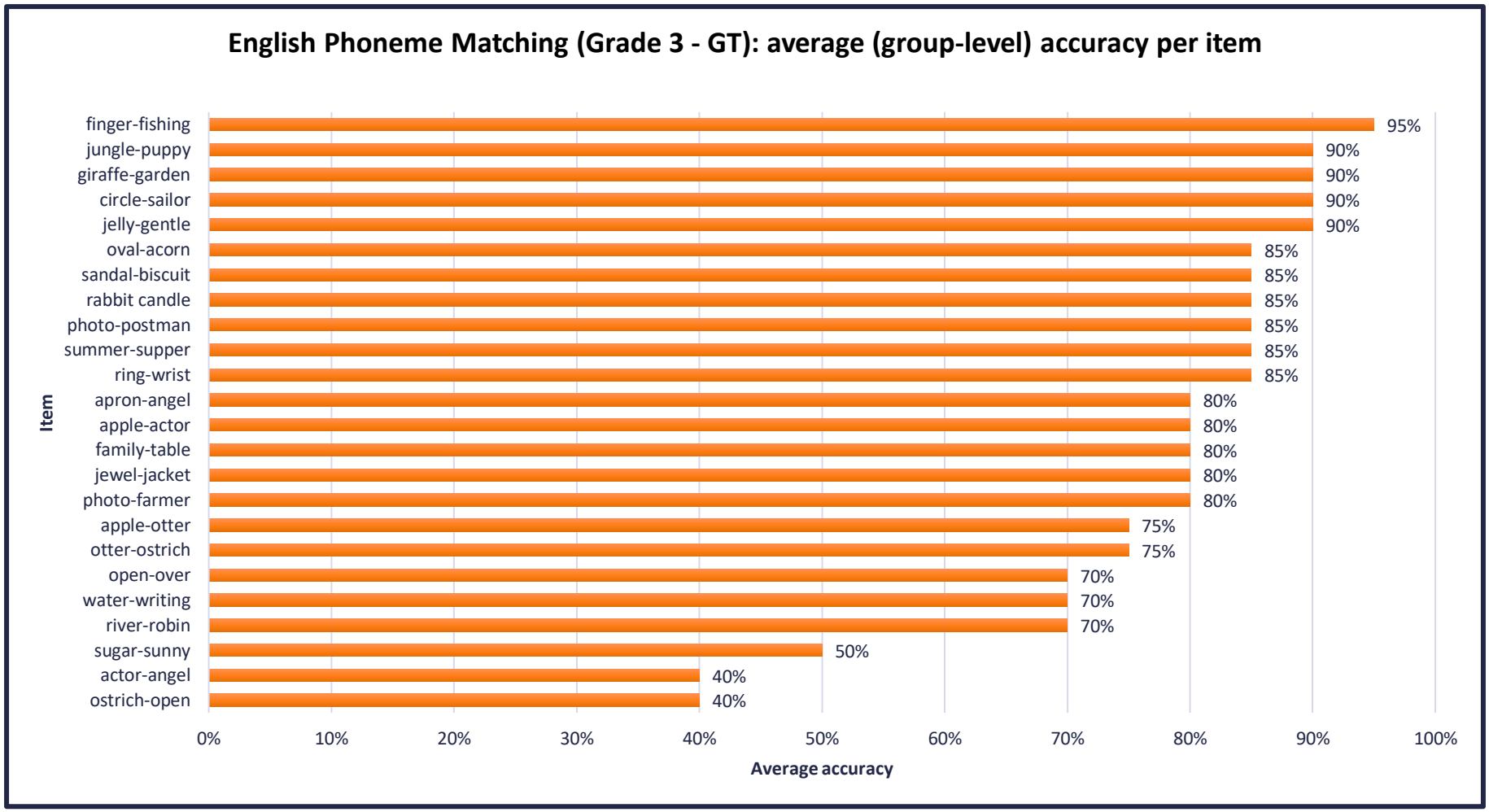

Figure 45 Grade 3 Gaeltacht participants: average (group-level) accuracy per item in the English Phoneme Matching task

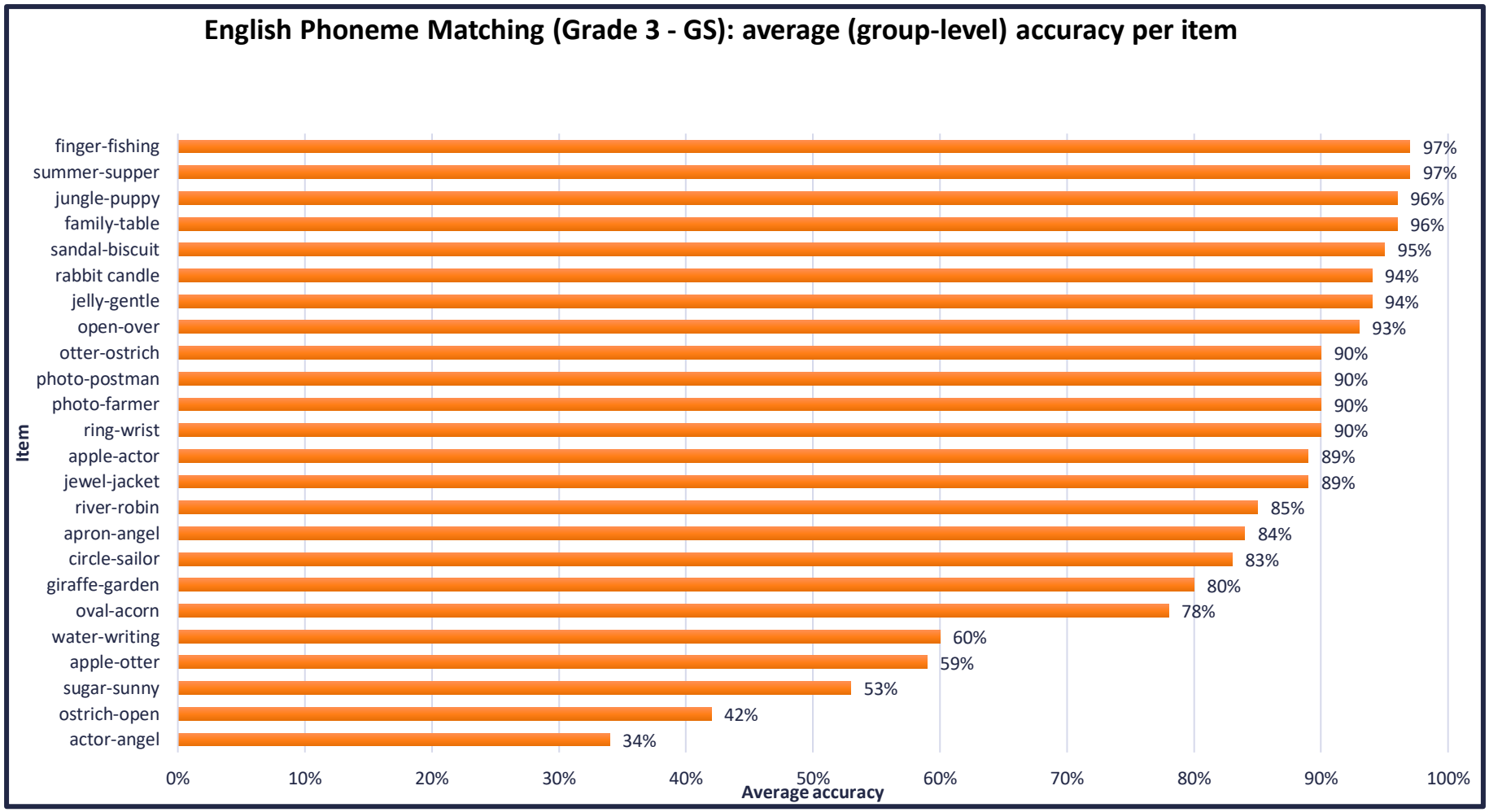

Figure 46 Grade 3 Gaeltacht participants: average (group-level) accuracy per item in the English Phoneme Matching task

6.3.2 Low average accuracy items at the group level: English Phoneme Matching

Low average accuracy items are examined in this section to investigate which phonological units in English posed a difficulty for participants.

Gaeltacht participants. Items with below 50% average (group-level) accuracy are reported in Table 33. In Grade 1, four items had below 50% accuracy. Two of these are vowel items, one matching (/a/-/a/) and one mismatching (/a/-/ɑ/); two are consonant items, one matching (/ɹ/-/ɹ/) and one mismatching (/w/-/ɹ/).

In Grade 2, three items had below 50% average accuracy; two were mismatching vowel items (/a/-/ɑ/ and /ɑ/-/oː/) and one was a mismatching consonant item /ʃ/-/s/). The consonant items /ʃ/-/s/ was also identified as the same phoneme by these participants in Irish.

In Grade 3, just two items had below 50% average accuracy rates; both mismatching vowel stimuli (/ɑ/-/oː/ and /a/-/eɪ/). These phonemes are both represented by the same vowel grapheme in English (<o> and <a>, respectively). The performance of the Grade 3 GT participants mirrors the performance on Grade 2 and Grade 3 GS participants on the task (see Table 34).

Table 33
Gaeltacht participants: English Phoneme Matching items with below 50% average (group-level) accuracy

Grade 1		Grade 2		Grade 3	
40%	water-writing /w/-/ɹ/	**38%**	sugar-sunny /ʃ/-/s/	**40%**	ostrich-open /ɑ/-/oː/
40%	apple-actor /a/-/a/	**43%**	apple-otter /a/-/ɑ/	**40%**	actor-angel /a/-/eɪ/
45%	ring-wrist /ɹ/-/ɹ/	**48%**	ostrich-open /ɑ/-/oː/		
45%	apple-otter /a/-/ɑ/				

Figure 47 plots the average (group-level) accuracy of each item which had lower than 50% average accuracy in any of the grades. There is a U-shaped trajectory for mismatching pairs /ʃ/-/s/ and /a/-/ɑ/, mirroring the trend of the GT group for the majority of the low average accuracy items in Irish. There is a downward trajectory for mismatching long-short vowel pairs /ɑ/-/oː/ and /a/-/eɪ/. These vowels are represented by the same letter in the orthography, which may have influenced performance; the effect of orthographic opacity

on responses to phoneme matching stimuli is further explored in § 7.1. The remaining pairs were only low average accuracy items in Grade 1; two have an upwards trajectory (/a/-/a/, /w/-/ɪ/) while one pair (/ɪ/-/ɪ/) has an inverted U-shaped trajectory with very high overall accuracy in Grade 2 and 3.

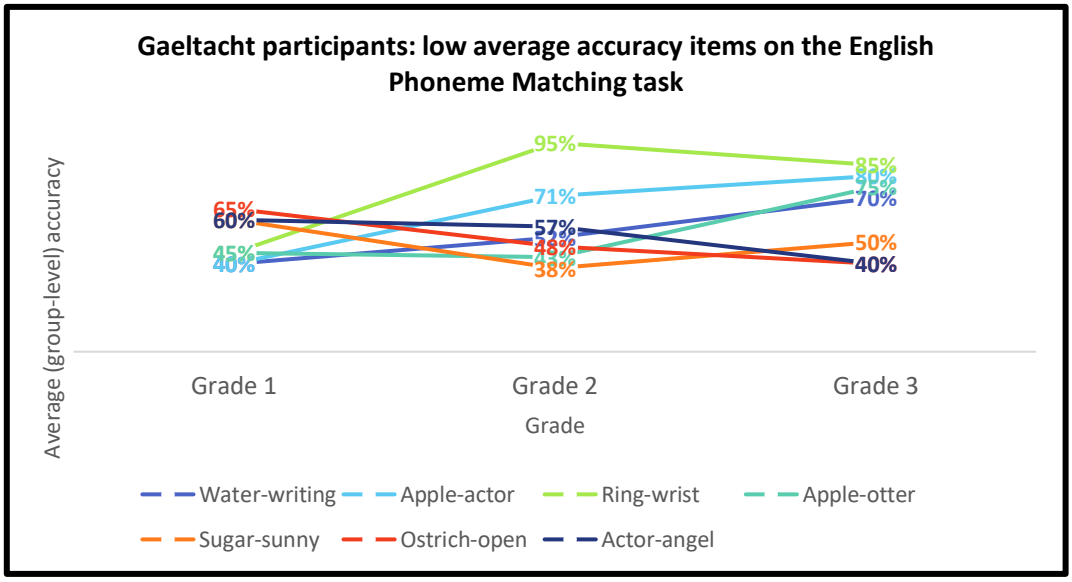

Figure 47 Gaeltacht participants: low average accuracy items on the English Phoneme Matching task. Low average accuracy items are pairs with less than 50% average accuracy at the group level in any grade.

Gaelscoil participants. Items with less than 50% average (group-level) accuracy are reported in Table 34. In Grade 1, there were no items below the 50% average accuracy rate. In Grade 2 and Grade 3, just two items had below 50% accuracy rates. Both of these items contained mismatching vowel stimuli (/ɑ/-/oː/ and /a/-/eɪ/). These phonemes are both represented by the same consonant grapheme in English (<o> and <a>, respectively).

Table 34
Gaelscoil participants: English Phoneme Matching items with below 50% average (group-level) accuracy

Grade 1		Grade 2		Grade 3
	38%	ostrich-open /ɑ/-/oː/	**34%**	actor-angel /a/-/eɪ/
	43%	actor-angel /a/-/eɪ/	**42%**	ostrich-open /ɑ/-/oː/

Figure 48 plots the average (group-level) accuracy of each item which had lower than 50% average accuracy in any of the grades. Note that only two of these pairs were identified as low accuracy items in the GS group (ɑ/-/oː/ and /a/-/eɪ/), the others are included for comparative purposes as they were identified as low accuracy items in the GT group. Of the two pairs that are low accuracy items in the GS group, /a/-/eɪ/ (along with /ʃ/-/s/).) has

a downward trajectory, while /ɑ/-/oː/ has a U-shaped trajectory. Orthographic opacity may have affected performance in these cases, a topic which is explored further in § 6.1. Of the other four pairs (which were low accuracy items only for the Grade 1 GT group), two have a steady trajectory (mismatching pairs /a/-/ɑ/, and /w/-/ɪ/), while two have an upward trajectory (matching pairs /ɪ/-/ɪ/) and /a/-/a/).

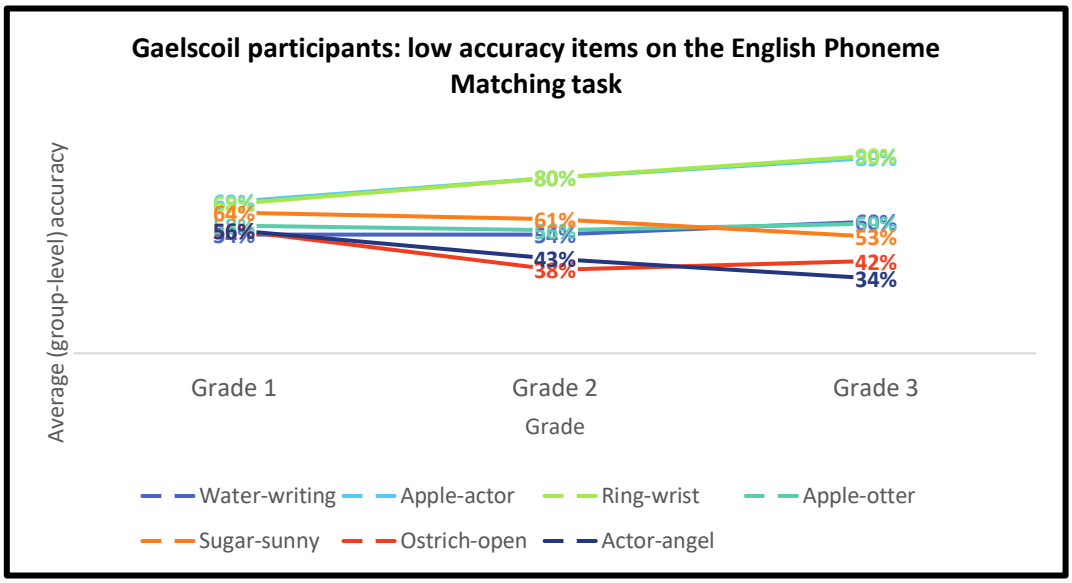

Figure 48 Gaelscoil participants: low average accuracy items on the English Phoneme Matching task. Low average accuracy items were pairs with less than 50% average accuracy at the group level in any grade. Note that only two pairs (ostrich-open and actor-angel) were low accuracy items in the GS group. The other four pairs are included for comparability, as they were low accuracy items in the Grade 1 GT group.

6.3.3 Summary

An analysis of items on the Phoneme Matching task indicates that the most consistent low average accuracy items were the velarised-palatalised consonant contrasts in Irish, as well as vowels contrasts which are represented by the same grapheme in both Irish and English.

6.4 Velarised-palatalised consonant contrasts in Irish

The velarised-palatalised consonant contrasts show consistently low average accuracy rates in both GS and GT groups in Irish, and are not paralleled in the English consonant stimuli. In § 6.4.1, the Phoneme Matching scores are re-analysed in order to investigate whether a cross-linguistic difference remains when the velarised-palatalised consonants omitted from the Irish scores (along with equivalent items in English). Then, in § 6.4.2, differences in median scores across grades are investigated to establish when awareness of the velarised-palatalised contrasts peaks. This section is not intended to provide answers to a particular research question, but instead to provide additional data to support findings in relation to Research Questions 1, 2 and 3.

6.4.1 Source of cross-linguistic variation in Phoneme Matching scores

In order to establish whether the velarised-palatalised consonant contrasts in Irish are the source of cross-linguistic differences in Phoneme Matching scores, the data is re-analysed here with these items omitted. The four items which involve the velarised-palatalised consonantal contrasts were removed from the analysis of the Irish Phoneme Matching scores, and four equivalent items (mismatching, orthographically opaque consonantal stimuli: discussed further in § 7.1.1) were removed from the English scores. With these items removed, the analysis is based on 20 items in each language, 12 of which were consonant items and 8 of which are vowel items. The median scores of this amended version of the Phoneme Matching task are illustrated in Figure 49 (Gaeltacht participants) and Figure 50 (Gaelscoil participants).

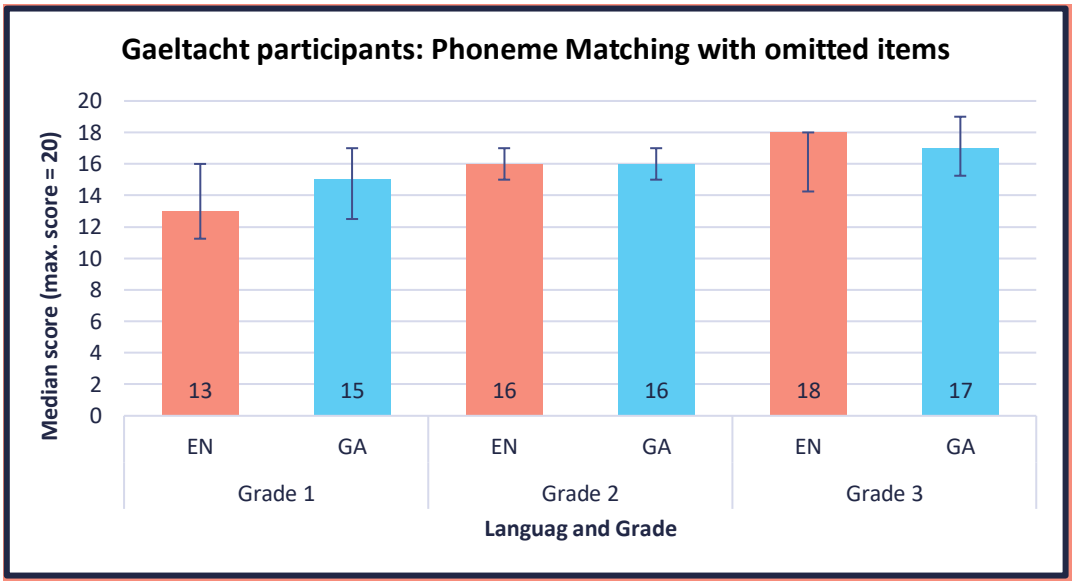

Figure 49 Gaeltacht participants: median Phoneme Matching score with omitted items. There was no statistically significant cross-linguistic differences identified when velarised-palatalised consonantal contrasts (and four equivalent English stimuli) were removed from the analysis. Note: EN = English; GA = Irish. Error bars represent the interquartile range values

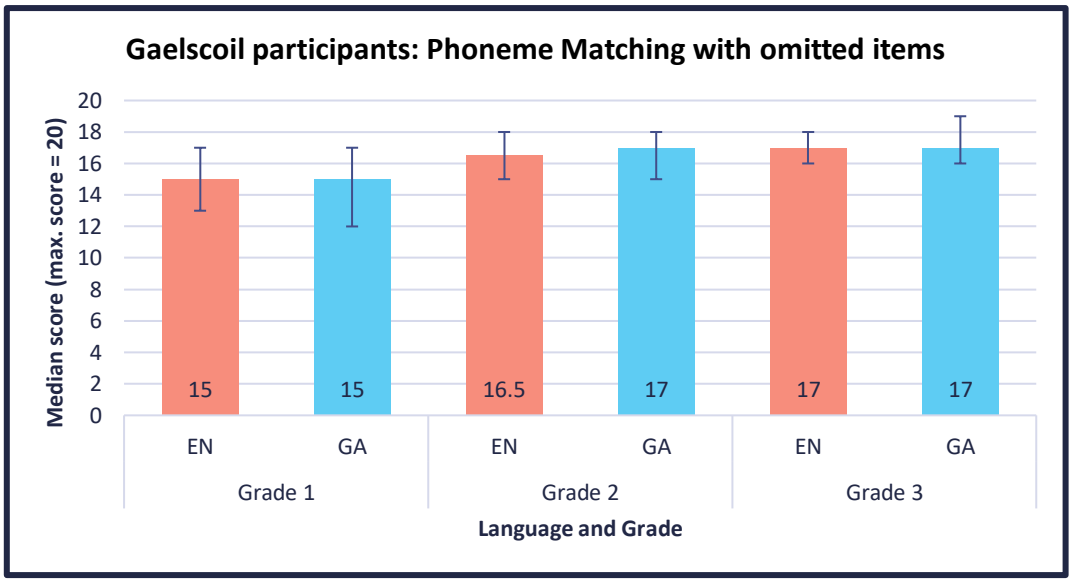

Figure 50 Gaelscoil participants: median Phoneme Matching scores with omitted items. There were no statistically-significant cross-linguistic differences identified when velarised-palatalised consonantal contrasts (and four equivalent English stimuli) were removed from the analysis. Note: EN = English; GA = Irish. Error bars represent the interquartile range values

Though differences in the median values remain, the results of the sign test in Table 35 indicate that there is no significant difference in scores on the English and Irish versions of Phoneme Matching task when these stimuli are removed, indicating that the velarised-palatalised consonant contrasts are the main source of cross-linguistic difference in performance.

Table 35
Sign test results: re-analysis of Phoneme Matching scores in Irish and English. The significance level (p-value) was set at 0.05.

	Gaeltacht				Gaelscoil			
	Mdn EN	Mdn GA	Z	p	Mdn EN	Mdn GA	Z	p
Grade 1	13	15	.750	.454	15	15	-.875	.382
Grade 2	16	16	.000	1.000	16.5	17	.606	.544
Grade 3	18	17	-1.250	.210	17	17	1.302	.193

6.4.2 Comparison across grades.

Based on average accuracy ratings of individual items presented in § 6.3, it appears that accuracy peaks in Grade 1 for both the GT and GS groups. In light of this, the median number of velarised-palatalised consonant items accurately identified as mismatching by each age group is examined in Table 36 (the mean value is also provided due to their more gradient nature, in comparison to the median values which are provided in whole units).

Table 36
Accuracy in identifying mismatching velarised-palatalised consonantal contrasts per grade: mean, median and range.

	Gaeltacht participants			Gaelscoil participants		
	Mean (SD)	Median (var.)	Range	Mean (SD)	Median (var.)	Range
Grade 1	1.82 (1.4)	2 (1.8)	0-4	1.55 (1)	2 (1.1)	0-4
Grade 2	.86 (.79)	1 (.62)	0-3	1.15 (.98)	1 (.97)	0-4
Grade 3	1.30 (1.1)	2 (1.2)	0-3	.95 (.90)	1 (.82)	0-4

The median scores - displayed in Figure 51 - suggest that the accuracy of Grade 1 GT participants in distinguishing between the velarised-palatalised consonantal contrasts peaks in Grade 1, falls in Grade 2 and increases again in Grade 3. The results of the Kruskal-Wallis test in Table 37 confirm that there is a statistically significant difference between the scores of Grade 1 and Grade 2 participants, but not between Grade 2 and 3 participants or between Grade 1 and Grade 3 participants in the GT group.

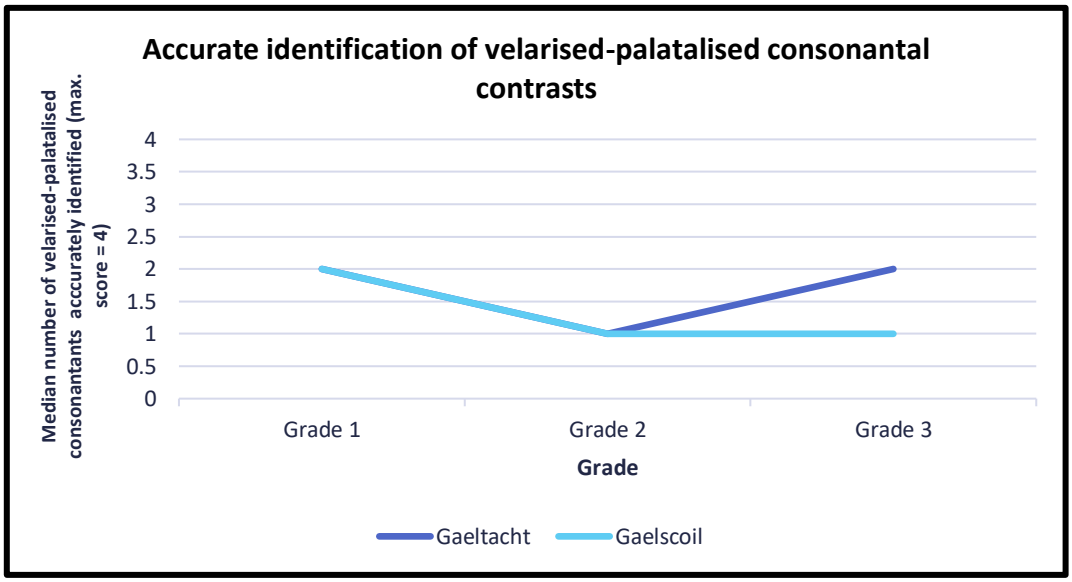

Figure 51 Median (group-level) accuracy in identifying velarised-palatalised consonant contrasts in Grade 1, 2 and 3. Light blue line indicates Gaelscoil score, dark blue line indicates Gaeltacht score

In contrast, the accuracy of GS participants in distinguishing between these contrasts peaks in Grade 1, and falls in Grade 2 and 3. The Kruskal-Wallis test – presented in Table 37 - indicates that scores are significantly lower in Grade 2 than in Grade 1, and significantly lower in Grade 3 than in Grade 2.

These trends mirror the trends for the individual pairs of velarised-palatalised consonant contrasts, displayed in Figure 39 and Figure 40; while accuracy for GT participants in different grades is characterised by a U-shaped trajectory, accuracy for the GS participants in different grades is characterised by a downward trajectory.

Table 37
Kruskal-Wallis test results: differences in Irish Phoneme Matching scores between grades. Note: the significance level was set at 0.05; statistically-significant valued are in bold.

	Gaeltacht participants		Gaelscoil participants	
	H statistic	p-value	H statistic	p-value
Grade 1 – Grade 2	13.344	**.040**	32.463	**.032**
Grade 2 – Grade 3	-7.596	.506	15.018	1.0
Grade 3 – Grade 1	1.053	.877	4.177	**.000**

6.5 Chapter summary

The question of whether participants have a common underlying proficiency in Irish and English in phonological, cognitive and literacy domains was examined in § 6.1. The results of a sign test indicated that there was no significant difference in the Irish and English scores on three of the tasks: Phoneme Deletion, Word Reading and Spelling . In addition, there was no significant difference in Irish and English Forward Word Span scores in any group except the Grade 1 GS participants, who had significantly higher scores in English. In contrast, there was a significant difference between Irish and English scores on two of the tasks. The GT groups completed the Irish version of the RAN task faster, while the GS groups completed the English version of the RAN task faster. In addition, participants had significantly higher Phoneme Matching scores in English than in Irish, with the exception of the Grade 1 GT participants.

This finding of cross-linguistic variation in Phoneme Matching scores was compounded by the findings of a correlationary analysis, indicating that while there is a strong correlation between Phoneme Deletion scores in each language, there is a moderate correlation between Phoneme Matching scores in each language. Items with low average (group-level) accuracy on the Phoneme Matching task were analysed. Vowel contrasts which are represented by the same grapheme in each language had below 50% group level accuracy, as did the velarised and palatalised consonant contrasts in Irish. On the English version of the task, there were different patterns of performance in GS and GT groups. In Grade 1, the GT group had four low accuracy items centered around /ɹ/ and the open vowels /a/ and /ɑ/, while the GS group had no low accuracy items. In Grade 2, the GT group had three low accuracy vowel items which involved the open vowels /a/-/ɑ/, long and short vowels /ɑ/-/o/, and mismatching consonants /ʃ/-/s/. The Grade 2 GS group, and Grade 3 GS and GT groups all had the same low accuracy items: mismatching vowel stimuli (/ɑ/-/oː/, /a/-/eɪ/, pairs represented by the same vowel grapheme in English.

On the Irish version of the task, the low accuracy items involved the long-short vowel contrasts and the velarised-palatalised consonantal contrasts for all groups. Hypothesising that the significant difference in Irish and English scores on the Phoneme Matching task (established in § 6.1) occurred as a result of the low average accuracy on the velarised-palatalised consonant contrasts in Irish, a sign test was carried out with these four items removed, as well as four equivalent items from the English task. This test indicated that no significant difference remained in Irish and English scores when these items were removed, indicating that they are the main source of cross-linguistic difference.

CHAPTER 7

RESULTS: BILINGUAL PHONOLOGICAL-ORTHOGRAPHIC INTERFACES

This chapter details the results pertaining to Research Questions 4 and 5 which investigate connections between phonology and orthography. Two separate themes are explored as part of this. Firstly, using data derived from the English versions of tasks, the effect of orthographic representations on responses to the Phoneme Matching task and the Phoneme Deletion task are investigated in § 7.1. Then, based on their response to the Phoneme Deletion task, participants are divided into a phonological strategy group and an orthographic strategy group. The Word Reading and Spelling scores of each group are compared to investigate whether there is a statistically significant difference between groups in § 7.2.

The second theme explored in this chapter examines the spelling errors made by participants in both Irish and English. In § 7.3, spelling errors are classified by type and analysed. The proportion of errors which relate to the low accuracy items on the Phoneme Matching task (identified in the last chapter) is investigated in § 7.3.4.

7.1 The effect of orthographic representations on responses to phonemic awareness tasks

This section aims to answer Research Question 5a:

> **Is there evidence of orthographic effects or the use of orthographic strategies on responses to linguistic and/or metalinguistic phonemic awareness tasks?**

This question is of interest with regard to the validity of PA as a purely phonological construct, independent of any influence from orthography. It is also of interest in a very specific way in this study due to the orthographically-opaque representation of the velarised-palatalised consonantal contrasts, in which two distinct phonemes are represented by the same consonant grapheme (and distinguished by the neighbouring vowel grapheme). The effect of the orthographic opacity on responses to the Phoneme Matching task in English is investigated in § 7.1.1. The effect of orthographic representations on responses to the Phoneme Deletion task is examined in § 7.1.2, using an additional item included in the English version of this task.

7.1.1 The effect of orthographic opacity on responses to the English Phoneme Matching task

The English version of the Phoneme Matching task contained four consonantal conditions, each containing four stimuli (outlined in Figure 52). Two of them were matching: one orthographically transparent (same letter, same phoneme: SLSP) and one orthographically opaque (different letter, same phoneme: DLSP). There were also two mismatching conditions: one transparent (different letter, different phoneme: DLDP) and one opaque (same letter, different phoneme: SLDP). This final condition (SLDP) for English mirrors the condition of the velarised-palatalised consonantal contrasts in Irish.

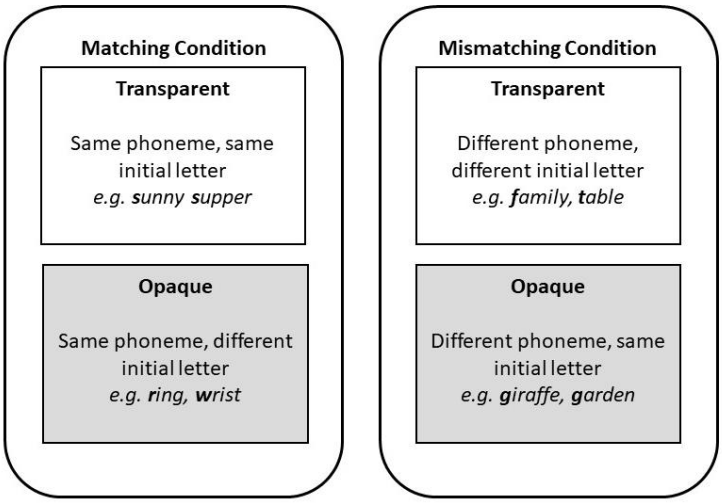

Figure 52 Orthographic conditions in the English Phoneme Matching task

Median scores on the matching conditions (DLSP and SLSP) are illustrated in Figure 53. A sign test was conducted to examine whether there was a significant difference in scores obtained in the orthographically transparent (SLSP) and orthographically opaque (DLSP) matching conditions. The results in Table 38 illustrate that there is no statistically significant difference in scores on the two conditions in any grade in either the GT or GS group.

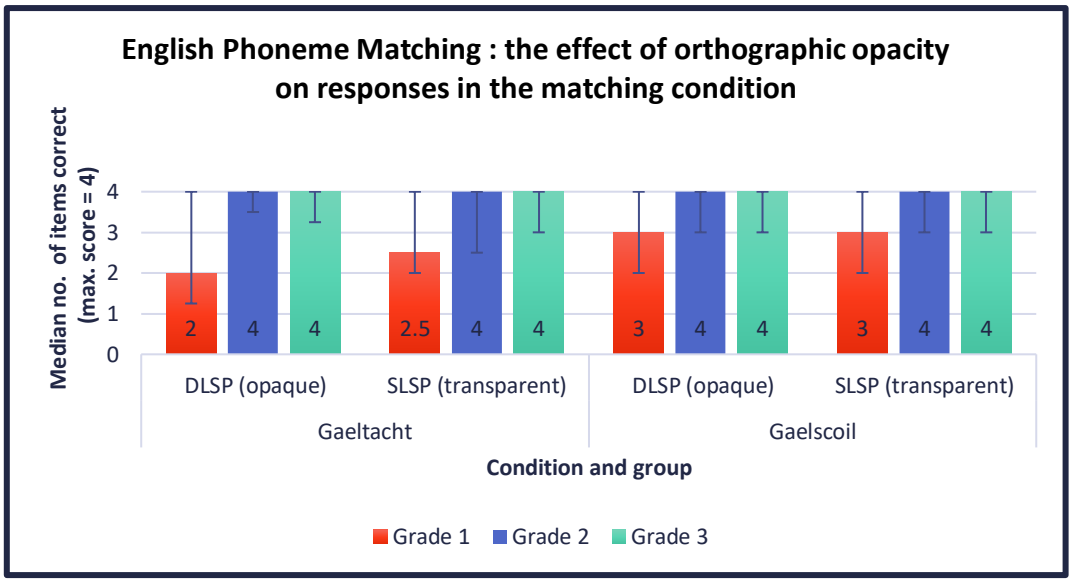

Figure 53 English Phoneme Matching task: the effect of orthographic opacity on responses in the matching condition. There was no significant difference between scores pertainint to opaque stimuli (the DLSP condition) and transparent stimuli (the SLSP condition).

Table 38

Sign test results: orthographic opacity in the matching condition of the English Phoneme Matching task (DLSP vs SLSP. Note: Z-statistic value +/- 1.96 (equivalent to p-value of <0.05) indicate a significant difference between conditions.

	Gaeltacht				Gaelscoil			
	DLSP (IQR)	SLSP (IQR)	Z	p	DLSP (IQR)	SLSP (IQR)	Z	p
Grade 1	2 (2.75)	2.5 (2)	1.206	.207	3 (2)	3 (2)	-.915	.360
Grade 2	4 (.5)	4 (1.5)	-1.081	.289	4 (1)	4 (1)	.476	.634
Grade 3	4 (1)	4 (1)	-.345	.727	4 (1)	4 (1)	1.237	.216

The median scores on the mismatching conditions are presented in Figure 54. A sign test was conducted to examine whether there was a significant difference in scores on the orthographically transparent (DLDP) and orthographically opaque (SLDP) mismatching conditions. The results in Table 39 indicate that significantly lower scores were obtained on the orthographically opaque condition in every grade in both the GS and GT groups.

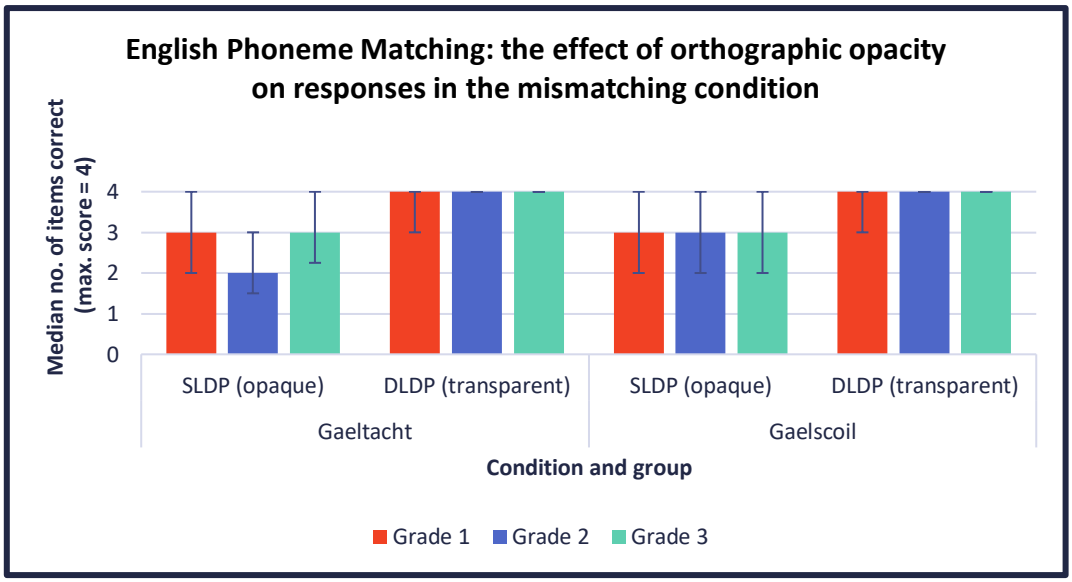

Figure 54 English Phoneme Matching task: the effect of orthographic opacity on responses in the mismatching condition. Scores were significantly higher on the transparent condition (DLDP) than on the opaque condition (SLSP).

Table 39

Sign test results: orthographic opacity in the matching condition of the English Phoneme Matching task: SLDP vs DLDP. Note: Z-statistic value +/- 1.96 (equivalent to p-value of <0.05) indicate a significant difference between conditions. Significant results are in bold.

	Gaeltacht				Gaelscoil			
	Mdn SLDP	Mdn DLDP	Z	p	Mdn	Mdn	Z	p
Grade 1	3	4	2.219	**.022**	3	4	4.76	**.000**
Grade 2	2	4	3.881	**.000**	3	4	5.960	**.000**
Grade 3	3	4	2.02	**.039**	3	4	7.46	**.000**

These contrasting findings indicate an assymetric influence of orthographic opacity on responses to the word-to-word matcing task. While significantly lower scores were obtained on the orthographically-opaque mismatching condition, this was not the case on the orthographically-opaque matching condition. Due to the very small number of stimuli investigated, this is a tentative finding and would need to be replicated on a larger scale.

7.1.2 Orthographic strategy use on the English Phoneme Deletion task (rocks-box stimuli)

This section investigates whether there is evidence of orthographic strategy use on the Phoneme Deletion task. Two stimuli with the same number of phonemes (*box* /bɒks/ and rocks /ɹɒks/) were included on the English Phoneme Deletion task[45]. In one stimulus (*rocks*), the phonemes /k/ and /s/ are represented by separate graphemes, while in the other stimulus (*box*), they are represented by a single biphonemic grapheme. Participants who accurately deleted the /s/ from /ɹɒks/ but deleted /k/ and /s/ from /bɒks/ were considered to be influenced by orthographic representations, or to be using an orthographic strategy.

Three groups of participants are delineated according to their response to these stimuli. Group A provided inaccurate responses, Group B gave an accurate response to *rocks* /ɹɒk/ but not to *box* /bɒ/ (indicating use of an orthographic strategy), Group C responded accurately to both *rocks* and *box* (indicating a phonological strategy). The number and percentage of participants in each group is reported in Table 40 and illustrated in Figure 55.

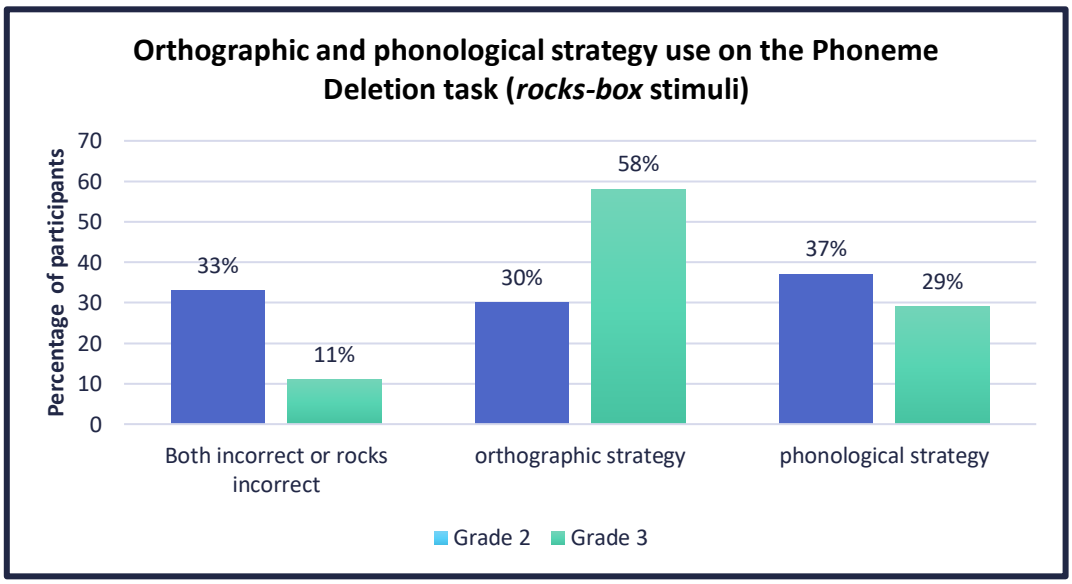

Figure 55 Orthographic and phonological strategy use on the English Phoneme Deletion task in Grade 2 and 3.

It is evident that the majority of Grade 2 participants (37%) used a phonological strategy, while a smaller number used an orthographic strategy (30%). In Grade 3, the majority of Grade 3 participants (58%) used an orthographic strategy, and a minority used a phonological strategy (29%).

[45] *Box* is an additional stimulus included in the English Phoneme Deletion task specifically to investigate orthographic effects; it is not included in any of the other analyses.

Table 40
Phonological and orthographic strategy use in the English Phoneme Deletion task: number and proportion of participants per grade

Group		Grade 2	%	Grade 3	%
A	**Inaccurate responses**				
	box incorrect, *rocks* incorrect	38	33	14	11
	box correct, *rocks* incorrect	0		2	2
B	**Orthographic strategy** *box* incorrect, *rocks* correct	34	30	73	58
C	**Phonological strategy** *box* correct, *rocks* correct	43	37	36	29

7.1.3 Summary

The effect of orthographic opacity on responses to the English Phoneme Matching task was investigated and an asymmetric finding obtained. While median scores were significantly lower on orthographically opaque consonant stimuli in the mismatching condition (same grapheme, different phoneme), there was no significant difference between scores on orthographically opaque and transparent stimuli in the matching condition (different grapheme, same phoneme). In addition, the use of an orthographic strategy on the Phoneme Deletion task was examined. It was found that while the majority of Grade 2 participants used a phonological strategy, the majority of Grade 3 participants used an orthographic strategy.

7.2 The relationship between orthographic strategies (*rocks-box* stimuli) and literacy attainment

This section investigates whether those who use an orthographic strategy in the Phoneme Deletion task had a higher level of literacy attainment than those who used a phonological strategy and those who provide incorrect responses. This aims to provide evidence in relation to Research Question 5b:

> **Is there a relationship between the use of orthographic strategies and literacy attainment?**

This is investigated separately for Grade 2 Irish Word Reading (§ 7.2.1), Grade 3 Irish Word Reading and Spelling (§ 7.2.2) and Grade 3 English Word Reading and Spelling (§ 7.2.3). The median Word Reading and Spelling score for each group (incorrect responses, orthographic strategy group and phonological strategy group) is reported in Table 41.

Table 41
Descriptive statistics: Word Reading and Spelling scores of the orthographic strategy group and phonological strategy group. Note: IQR = Interquartile Range

	Incorrect responses (Group A)		Orthographic strategy (Group B)		Phonological strategy (Group C)	
	Median	IQR	Median	IQR	Median	IQR
Grade 2 Irish Word Reading accuracy (max. score = 20)	7	6.5	16.5	7.5	14	13
Grade 3 Irish Word Reading accuracy (max. score = 40)	9	22.5	31	21.5	25.5	16.25
Grade 3 Irish Spelling (max. score = 8)	2	2	5	5	4	2
Grade 3 English Word Reading accuracy (max. score = 40).	8	12	30	25.5	25.5	21
Grade 3 English Spelling (max. score = 8)	2	2	5	3.5	4	3

7.2.1 Orthographic strategy use and Grade 2 Irish Word Reading

The median Grade 2 Irish Word Reading scores of the orthographic strategy group and phonological strategy group, as well as those who gave incorrect responses, is illustrated in Figure 56.

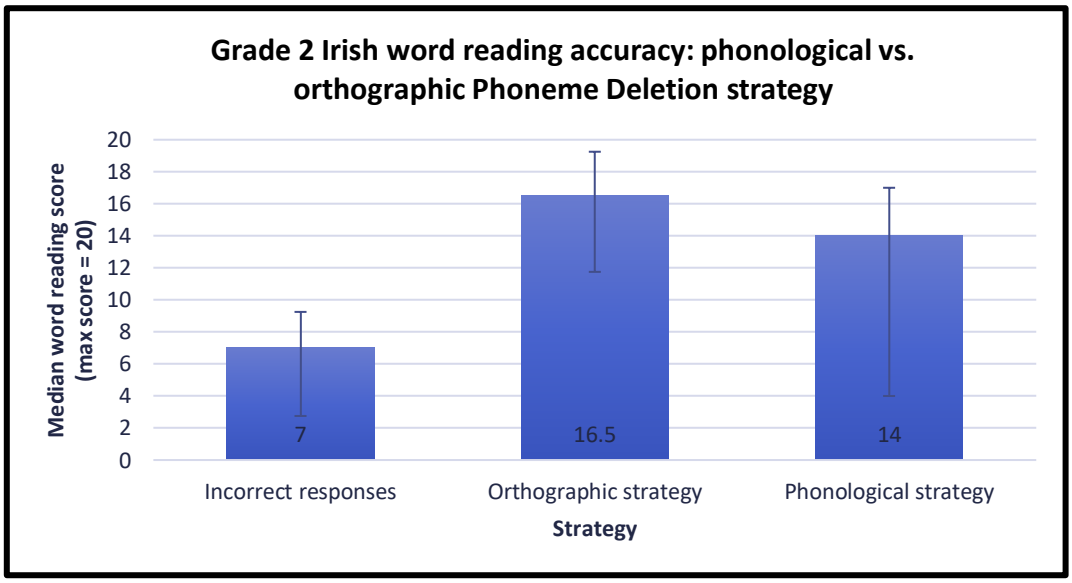

Figure 56 Phonological vs orthographic strategies on the English Phoneme Deletion task: median Irish Word Reading accuracy score per group (Grade 2). Note: error bars represent the interquartile range values.

The orthographic strategy (OS) group have the highest median score on Grade 2 Irish Word Reading, followed by the phonological (PS) group. Both the PS and OS groups have a higher median Word Reading score than the group that provided inaccurate responses to these items. A Kruskal-Wallis test was conducted to examine whether the difference in median Word Reading attainment between each Grade 2 group was significant. The results in Table 42 indicate that there is a statistically significant difference between each group;

the OS group had significantly higher Word Reading scores than the PS group (p=.048), and those who responded inaccurately to these items (p<.001). The PS group also had significantly higher Word Reading score than those who responded inaccurately to these items.

Table 42
Kruskal-Wallis test of differences in medians: Grade 2 Irish Word Reading score according to strategy type.

	H statistic	p-value[46]
Group B- Group A	-5.10	**.000**
Group C- Group B	2.41	**.048**
Group C- Group A	-2.92	**.003**

7.2.2 Orthographic strategy use and Grade 3 Irish Word Reading and Spelling

The median Grade 3 Irish Word Reading and Spelling scores of the orthographic strategy group and phonological strategy group, as well as those who gave incorrect responses, is illustrated in Figure 57 and Figure 58.

The OS group had the highest median Irish Word Reading and Spelling score in Grade 3, followed by the PS group and then those who provided incorrect responses. A Kruskal-Wallis Test (presented in Table 43) was carried out to investigate whether these differences were statistically significant. The results indicate that while the OS group and the PS group had significantly higher Word Reading and Spelling scores than their peers who provided incorrect responses, there was not a statistically significance difference between the OS and the PS groups in Irish Word Reading and Spelling scores.

[46] The p-values reported here include the Bonferroni adjustment for multiple tests.

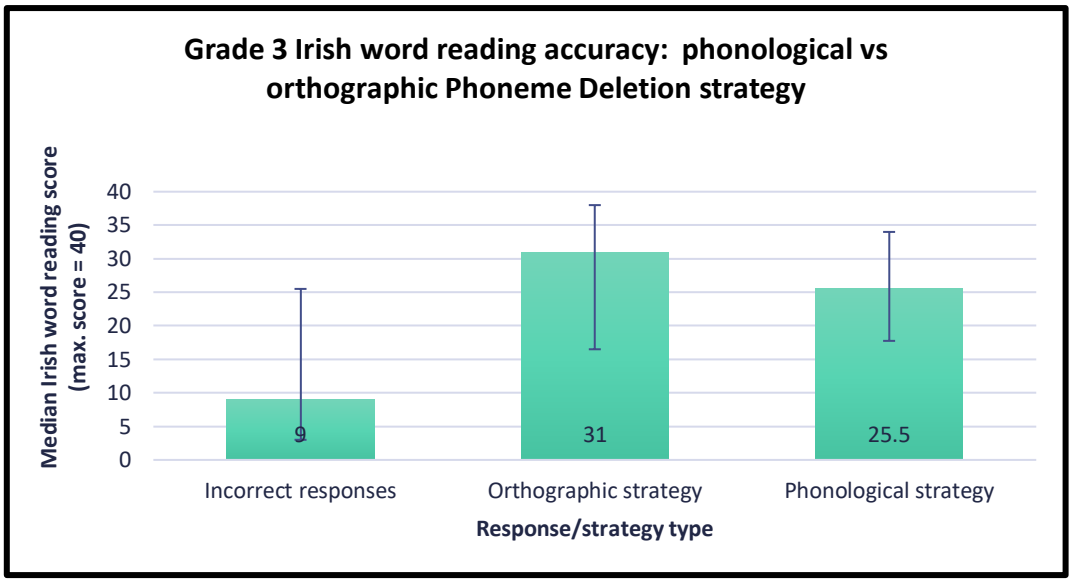

Figure 57 Phonological vs orthographic strategies on the English Phoneme Deletion task: median Irish Word Reading accuracy score per group (Grade 3).

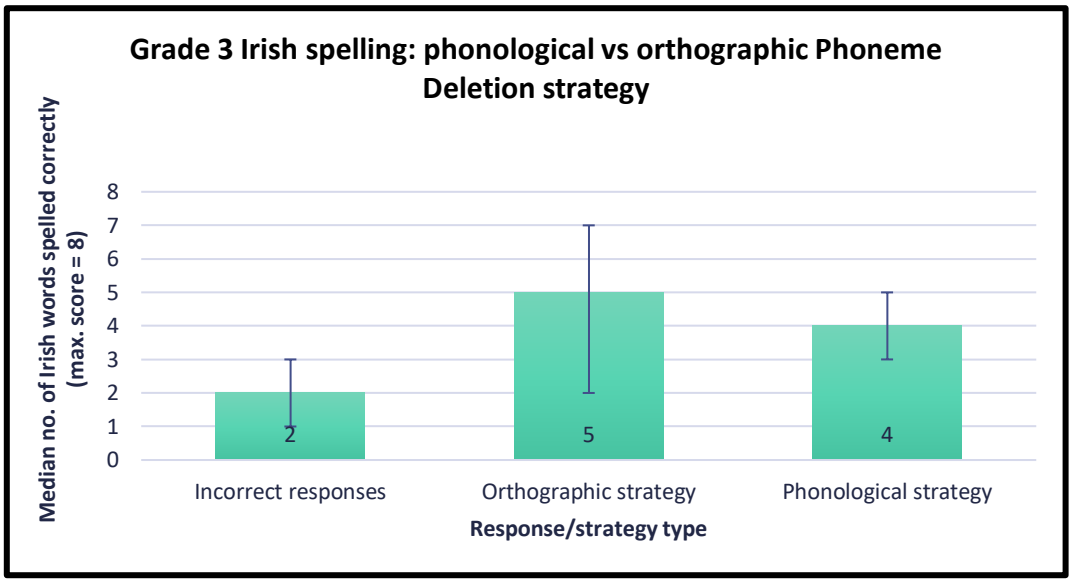

Figure 58 Figure 6 Phonological vs orthographic strategies on the English Phoneme Deletion task: median Irish Spelling score per group (Grade 3).

7.2.3 Orthographic strategy use and Grade 3 English Word Reading and Spelling.

The median Grade 3 Irish Word Reading and Spelling scores of the orthographic strategy group and phonological strategy group, as well as those who gave incorrect responses, is illustrated in Figure 59 and Figure 60.

The OS group had the highest median English Word Reading and Spelling score in Grade 3, followed by the PS group and then those who provided incorrect responses. This mirrors the findings in relation to Irish Word Reading and Spelling.

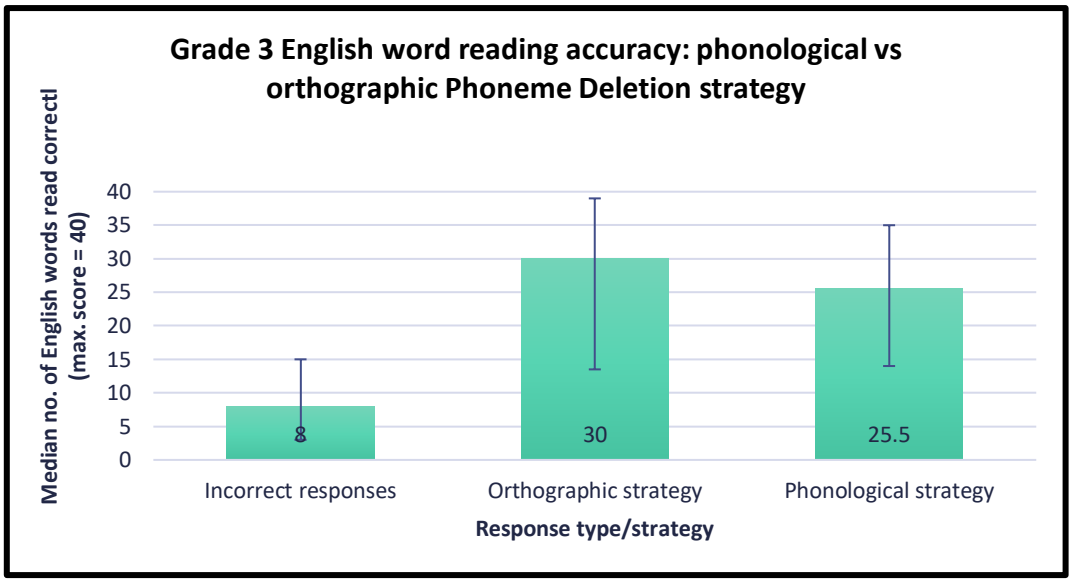

Figure 59 Phonological vs orthographic strategies on the English Phoneme Deletion task: median English Word Reading score per group (Grade 3).

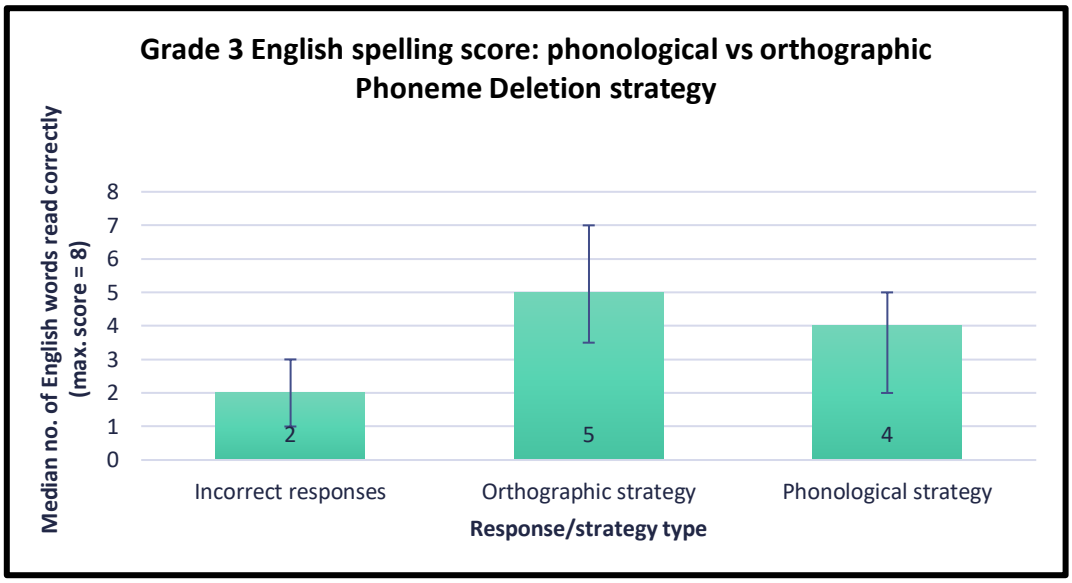

Figure 60 Phonological vs orthographic strategies on the English Phoneme Deletion task: median English Spelling score per group (Grade 3).

Again, a Kruskal-Wallis Test was carried out to investigate whether these differences were statistically significant. The results – presented in Table 43 - indicate that while the OS group and the PS group had significantly better Word Reading and Spelling scores than their peers who provided incorrect responses, there was not a statistically significance difference between the OS and the PS groups in English Word Reading and Spelling scores.

Table 43
Kruskal-Wallis test of differences in medians: Grade 3 Word Reading and Spelling scores per strategy type.

	Irish Word Reading		Irish Spelling		English Word Reading		English Spelling	
Group	H stat.	p-value	H stat.	p-value	H stat.	p-value	H stat.	p-value
A-B	-3.72	**.001**	-3.64	**.001**	-3.79	**.000**	-3.62	**.001**
B-C	.76	1.000	.687	1.000	.940	1.000	1.25	.633
A-C	-3.00	**.009**	-2.93	**.010**	-2.93	**.010**	-2.58	**.030**

7.2.4 Summary

This section compared the median Word Reading and Spelling scores of participants who used an orthographic strategy on the Phoneme Deletion task to those who used a phonological strategy, and found that the OS group had higher median literacy attainment scores in Grade 2 and Grade 3, though this difference was only significant in Grade 2. This would support the characterisation of Phoneme Deletion tasks as – at least in part – a measure of the degree of alphabetisation or the strength of phoneme-grapheme representations. This matter will be explored in the discussion.

7.3 Spelling error analysis: Irish and English

An analysis of spelling errors made in Irish and English is conducted in this section, addressing Research Question 4:

> **Are phonemic awareness errors reflected in the spelling errors made in Irish and English?**

The framework used to identify and categorise spelling errors is outlined in § 7.3.1. The phonological and orthographic errors made in each language are then quantified in § 7.3.2 for Irish and § 7.3.2 for English. A complete list of the errors made in each task and examples of each type are provided in Appendix 9 for Irish and Appendix 10 for English. A list of the target spellings along with a phonetic transcription is provided in Table 44.

Table 44
Stimuli included in the spelling task

Spelling task: stimuli			
Irish		**English**	
rós	ɾʸoːsʸ	red	ɹɛd
trá	tʸɾʸɑː	arm	ɑːɹm
cás	kʸɑːsʸ	tap	Tap
sásta	sʸɑːsʸtʸə	party	pɑɹtiː
súil	sʸuːlʲ	boat	boːt
fear	fʲaɾʸ	rope	roːp
carr	kʸɑːɾʸ	mess	mɛs
dubh	dʸuvʸ	sink	sɪŋk

7.3.1 Error analysis framework

A two-stage analysis was carried out on errors made in the Irish and English Spelling task. The first stage involved classifying the type of error made and the second stage involved suggesting a phonological or orthographic explanation for the error.

Stage 1: Identifying errors. The first stage of the analysis was to mark grapheme substitutions (e.g. the vowel grapheme in *party* <p**o**rty>), additions (e.g. <par**r**ty>), omissions (e.g. <prty>) and transpositions (e.g. <**pr**aty>). A grapheme corresponds to a single letter representing a phoneme in these examples, however letter strings which represent a single phoneme (e.g. <oa> in *boat*, <bh> in *dubh*) also correspond to a single grapheme. As a result, errors such as <bot> and <duf> are marked as a grapheme substitution. This avoids inflating the number of errors by counting, for example, the omission of /oː/ in spelling error <bt> as two errors.

It was decided to treat the vowel graphemes in Irish that denote consonant quality (e.g. the <e> grapheme in *fear* and the <i> grapheme in *súil*) as individual graphemes. The alternative would be to count the <il> as a grapheme corresponding to a single phoneme /lʲ/, however this would lead to counting certain errors twice. For example, the error <fer> would then be counted as both a consonant grapheme substitution and a vowel grapheme substitution. Treating these graphemes individually avoids inflating the number of errors by counting a single grapheme omission as two errors. As such, errors such as <far> and <súl> are treated as grapheme omission errors.

Where there were multiple errors in each word, each error was counted separately. There were various options in the classification of consonant cluster errors, however it was

decided to mark errors in which two consonant graphemes were accurate but in an incorrect order (e.g <tár> for *trá*), as a transposition error even if the vowel grapheme was inaccurate (e.g. <tír>). Though if one or more of the consonant graphemes were inaccurate (e.g. <tá**l**>), the errors were marked as a grapheme omission and a grapheme addition.

Stage 2: suggesting an explanation for errors. The categories of error and their characteristics are outlined in Table 45. An error is labelled *phonologically plausible* if the grapheme chosen accurately represents the phonological segment, even if it is not the grapheme conventionally used to spell a given word. Note that some have both a possible phonological basis and a possible orthographic basis. This system is an imperfect one as it is based on inference: as such, the explanations for errors are merely suggestions.

Table 45
Categories of spelling error: identification and classification

Classification	Error identification	Possible basis for error	Phonological plausibility
Voicing	Errors consistent with substituting a voiceless consonant grapheme with that of its voiced counterpart (e.g. <dap> for *tap*, <sásda> for *sásta*) or a voiced consonant grapheme with its voiceless counterpart.	*Phonological*: may accurately represent the phonology in certain cases (e.g. in *sásta*, the lack of aspiration in /t/ after /s/ make it perceptually similar to /d/)	Phonologically plausible
		Phonological: poor ability to distinguish between voiced and unvoiced versions of consonants (e.g. <dap> for *tap*)	Phonologically implausible
Unstressed vowels (Irish only)	Errors consistent with substituting a vowel in unstressed position with a more central vowel	*Phonological:* may have an accurate phonological basis in cases in which an unstressed vowel is reduced to a central vowel (e.g. the /ɛ̲/ in <sáste>)	May be phonologically plausible
	Errors consistent with omitting a vowel in an unstressed position (e.g <sást>)	*Phonological:* reduced salience of vowels in an unstressed position	Phonologically implausible.
Cluster	Errors consistent with omitting a consonant from a cluster (e.g. <sik> for *sink*) or inaccurately sequencing	*Phonological:* relative difficulty associated with segmenting a cluster of consonants and	Phonologically implausible

	phonemes in a cluster (e.g. <tár> for *trá*)	representing them accurately in sequence.	
Unexplained	General category of errors: all errors which do not fall under any other category of error but are not phonologically plausible (e.g. <bau> for *tap*, <crs> for *cás*). Note that for some of these errors e.g. <miss> for *mess*, there is a possible explanation (in this case, approximation to another real word), however they do not fall under any other category in the analysis framework.	*Phonological:* may occur as a result of poor ability to identify the phonemes in a spoken word *Orthographic:* may occur due to lack of awareness of phoneme-grapheme rules.	Phonologically implausible
Long-short vowels	Errors consistent with replacing a long vowel with its short counterpart (e.g. <bot> for *boat*) or a short vowel with its long counterpart (e.g. <dúbh> for *dubh*).	*Phonological:* poor ability to distinguish between long and short vowels in spoken words. *Orthographic:* more complex representation of long vowels (i.e. <oa> or <ó> for /o:/) or as a result of using the letter name to represent the phoneme (e.g <bot>)	Phonologically implausible.
Consonant marker (Irish only)	Errors in which the vowel marking consonant quality is omitted e.g. <far> for *fear*, <súl> for *súil.*	*Phonological:* poor ability to distinguish between the velarised and palatalised consonants. *Orthographic:* lack of awareness of how velarised and palatalised consonants are represented in the orthography.	Phonologically implausible in native speaker Irish; plausible in some non-traditional varieties.
Vowels a/o	Errors in which <a> or <á> is replaced with <o> (e.g. <porty>), less often, where <o> is replaced with <a>.	*Orthographic:* may occur in words where <a> corresponds to /ɑ/ (e.g. *arm*) as <o> is often used to represent this phoneme	Phonologically plausible

		in English (e.g. *lot, pot*, etc.)[47] *Orthographic:* may be due to visual similarity of the two vowel graphemes	
Séimhiú[48] **(Lenition)**	Errors consistent with leniting a consonant unnecessarily (e.g. <charr> for *carr*).	*Phonological:* lack of distinction between lenited and unlenited consonants. *Orthographic:* may occur due to frequency of exposure to the lenited versions of certain written words (e.g. *sa charr*).	Phonologically implausible
Alternative grapheme	Errors consistent with use of an alternative grapheme to represent a phoneme (distinction is not made between graphemes which are orthographically-legal[49] and those which are not)	*Orthographic:* may occur when each phoneme is individually coded using phoneme-grapheme rules, before word is stored as a sight word.	Phonologically plausible
Alternative grapheme in English/Irish	Errors consistent with use of a grapheme in the other language which corresponds to a similar phoneme as the target (e.g. <duv> for *dubh* or <róp> for *rope*)	*Orthographic:* interaction between the two orthographic systems.	Phonologically plausible
Letter name	Errors consistent with representing a phoneme using a letter name rather than the phoneme it represents e.g. representing the string /ti:/ with the letter <t>.	*Orthographic:* associating a grapheme with its name instead of (or in addition to) the phoneme(s) it represents.	Phonologically plausible
Letter reversal	Errors consistent with reversing the direction of a	*Orthographic:* may occur due to lack of awareness or	Phonologically implausible

[47] In *party*, the /a/ is retracted before /r/, yielding a quality that is acoustically close to the /ɑ/ phoneme of Irish-English.

[48] Séimhiú (lenition) is an initial mutation which results in a systematic change in the quality of the initial consonant (e.g. stops change to fricatives). In the orthography, the letter <h> is placed after the initial consonant e.g. <p> (representing /pʲ/ or /pˠ/) changes to <ph> (representing /fʲ/ or /fˠ/)

[49] An orthographically-illegal string of graphemes are those which do not occur in the lexicon. An example of an alternative grapheme used in an orthographically illegal way is <rowp> for rope. The string <ow> can be used to represent /o/ but the string <owp> does not occur in word-final position in English.

	consonant letter (e.g. <taq> for *tap*)	poor recall of the direction of the grapheme.	
Geminates	Errors consistent with including a geminate consonant unnecessarily (e.g. parrty)	*Orthographic:* overuse or inappropriate use of an orthographic rule	Phonologically plausible
	Errors consistent with omitting a geminate consonant (e.g. mes)	*Orthographic:* lack of awareness of orthographic rule	Phonologically plausible
Final -e (English only)	Errors consistent with including a word final -e when unnecessary	*Orthographic:* overuse or inappropriate use of an orthographic rule	Phonologically implausible

7.3.2 Analysis of Irish spelling errors

The number of errors per category in the Irish Spelling task is presented in Table 46, while Figure 61 presents the percentage of the total errors accounted for by each type of spelling error. Note that these categories are derived from an initial error analysis and each does not have an equal opportunity of occurring.

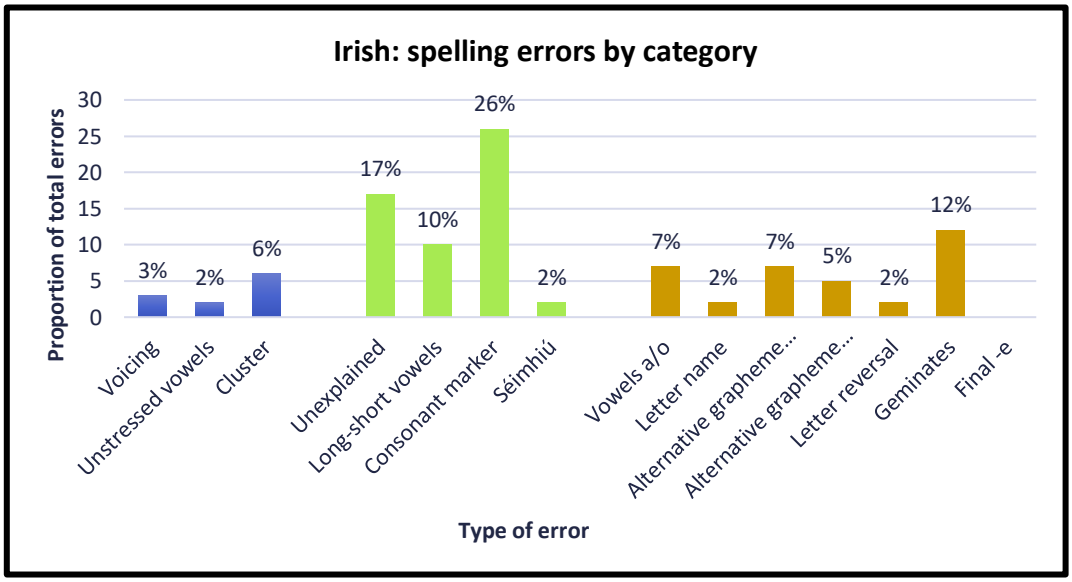

Figure 61 Irish spelling errors by category. The percentage value for each category is the proportion of the total errors accounted for by errors falling within that category. Categories with purple bars are considered to have a phonological explanation; categories with green bars are considered to have a possible phonological and possible orthographic explanation; categories with orange bars are considered to have an orthographic explanation.

Phonological. Errors with a phonological explanation – relating to voicing, unstressed vowels and consonant clusters - account for 11% of the total errors in Irish. Of these, consonant cluster errors account for the majority (6%) and occur in the words *trá* (e.g. <tá>) and *sásta* (e.g. <sáta>). Errors relating to voicing account for 3% of the total

errors and relate to the substitution of <tˠ> in *sásta* with its voiced counterpart (e.g. <sásda>) and the substitution of <vˠ> in *dubh* with its voiceless counterpart (e.g. <duf>). Errors relating to unstressed vowels account for 2% of the total errors and relate to the omission (e.g. <sást>) or reduction (e.g. <sáste) of the final vowel in *sásta* which is the only bisyllabic word in the Spelling task.

Phonological-orthographic. Errors which have a phonological and an orthographic explanation account for 55% of the total errors, of these 17% are the unexplained errors which have no obvious explanation. Errors relating to the addition of a lenition marker <h> after the initial consonant account for 2% of the total errors.

Errors which relate to omitting or substituting the vowels that mark consonant quality are the most common error, account for 26% of the total. This occurs in the words *fear* (e.g. <far>) and *súil* (e.g. <súl>). Errors relating to long and short vowel contrasts account for 10% of the total errors. The majority of these (45 of 55) pertain to the omission of the acute accent, resulting in the substitution of a long vowel with a short vowel (e.g <cas> for *cás*). The remaining 10 errors constitute the substitution of a long vowel with a short vowel (e.g. <dúbh> for *dubh*)

Orthographic. Errors with an orthographic explanation account for 35% of the total errors made. Of these, the most frequent were geminate errors (12% of total). The majority (50 of 66) relate to the omission of one of the geminate consonants in *carr*, resulting in the real, high frequency word *car* in English.

Replacing a grapheme with a phonologically-plausible alternative accounts for 7% of the errors. The majority (22 of 38) occur in the word *dubh*, where the vowel was replaced with <o> or the final consonant with <mh>. Another 8 of these errors occurred in *súil*, resulting in <súll>, possibly as a result of this grapheme's similarity to <i>, a marker of consonant quality in this word.

Confounding the <a> and <o> vowel graphemes also accounts for 7% of the errors, the majority of these (32 of 41 errors) are the substitution of graphemes representing /ɑː/ with <o>. A smaller number (9 errors) relate to the substitution of /a/ in *fear* with <o>, and just one is the replacement of <ó> with <a>. It is of note that the two target words with the highest number of these errors produce real high frequency words in Irish (*cos*, instead of *cás*) and English (*for* instead of *fear*).

Replacing a grapheme with an alternative grapheme in English accounted for 5%; the majority of these (22 of 25) are the substitution of <bh> (the phoneme vˠ) with <v> . The grapheme <v> occurs in just a small number of loan words in Irish. Letter reversal errors

account for 2% of the total errors and occur only in the word *dubh* where <d> and <b> appear in the same word. Errors relating to letter names also account for 2% of the total errors and occur only in *carr* (spelled <cr) and *fear* (spelled <fr), and pertain to <r> whose letter name is /ɔːɹ/ or /ɑːɹ/ in Irish-English.

Table 46
Irish spelling errors: number and percentage of total errors per category

	Target spelling									
	Rós	**Cás**	**Trá**	**Sásta**	**Súil**	**Fear**	**Carr**	**Dubh**	**Total**	**%**
Phonological										
Voicing				6				10	**16**	**3**
Unstressed vowels				11					**11**	**2**
Cluster			15	21					**36**	**6**
Phonological-orthographic										
Unexplained	5	9	12	5	14	22	11	15	**93**	**17**
Long-short vowels	16	8	3	10	8	7		3	**55**	**10**
Consonant marker					66	77			**143**	**26**
Séimhiú		2	2			1	2	2	**9**	**2**
Orthographic										
Vowels a/o	1	13	7	8		9	3		**41**	**7**
Letter name						7	2		**9**	**2**
Alternative grapheme (GA)	3				1		12	22	**38**	**7**
Alternative grapheme (EN)	1				2			22	**25**	**5**
Letter reversal								12	**12**	**2**
Geminates	2	1	1		8	4	50		**66**	**12**
Final -e										
Total	28	33	40	61	99	127	80	86	**554**	

7.3.3 Analysis of English spelling errors

The number of errors per category in the English Spelling task is presented in Table 47, while Figure 62 presents the percentage of the total errors accounted for by each type of spelling error.

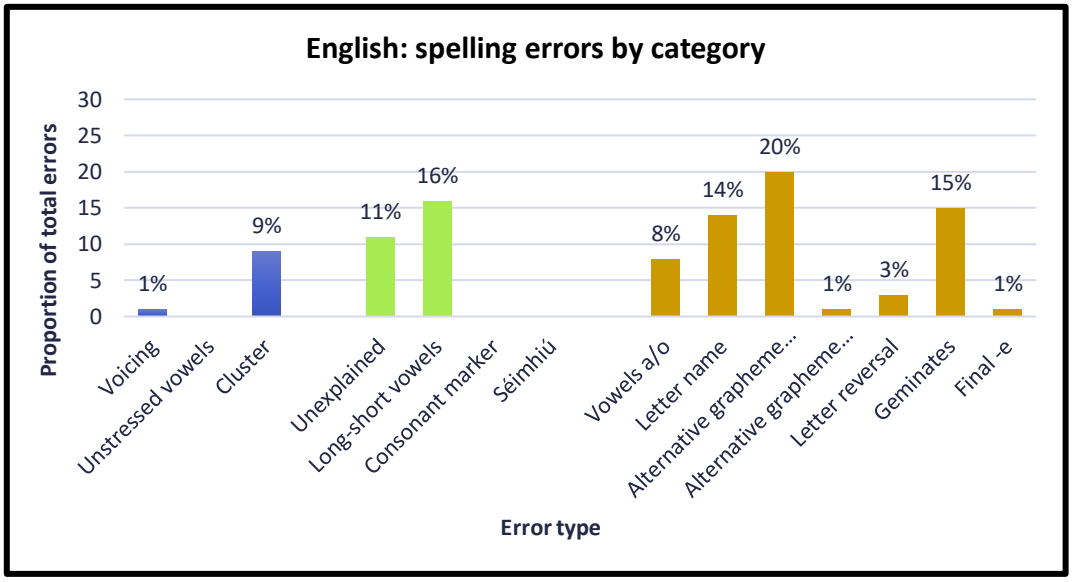

Figure 62 English spelling errors by category. Categories with purple bars are considered to have a phonological explanation; categories with green bars are considered to have a possible phonological and possible orthographic explanation; categories with orange bars are considered to have an orthographic explanation.

Phonological. Errors with a phonological explanation – errors in voicing and consonant clusters – account for 10% of the total errors in English. Of these, consonant cluster errors account for the vast majority (9%), including omissions and transpositions occurring in the words *arm* (e.g. <ram>, <om>), *party* (e.g. <pate>, <praty>) and *sink* (e.g. <sik>). Errors relating to voicing accounted for just 1% of the total errors. These include the substitution of the voiced stop represented by <d> with its voiceless counterpart in *red*, and the substitution of the voiceless stops corresponding to <t> with their voiced counterparts in *tap* and *boat,* as well as the substitution of the voiceless stop represented by <p> with its voiced counterpart in *party*. The single voicing-related error in *boat* occurs with a long-short vowel substitution (<bad>) and may be an approximation to the Irish word *bád* with the same meaning.

Phonological-orthographic. Errors which have both a possible phonological explanation and possible orthographic explanation account for 27% of the total errors, of these 11% are the errors that do not have any obvious explanation.

Errors relating to long and short vowels account for 16% of the total errors. These errors are confined to the words *boat* and *rope* and relate to the substitution of a long vowel with a short vowel (e.g. <bot>, <rop>).

Orthographic. Errors with an orthographic explanation account for 62% of the total errors. The most common error (accounting for 20% of the total) is the substitution of a grapheme with an alternative, phonologically-plausible grapheme. The majority of these errors (61 of 97) occur in the word *sink*. Of these, 13 errors relate to the substitution of <n> with <ng> to represent the velar nasal /ŋ/ in *sink*. The remainder relate to the substitution of <k> with <c>. A further 23 of the errors occur in the word *boat*, where an alternative spelling of the long vowel is used (<bote>). A small number also occur in *party* (e.g. <partey>), *rope* (e.g. <roap>) and *arm* (<ourm>),

A further 15% are errors relating to geminates. Of these, the majority (64 of 75) occur in the word *mess* and relate to the omission of one of the final geminate consonants (e.g. <mes>). A small number of geminate additions occur in the words *red* (<reed>), *tap* (<tappe>), *party* (<parrty>) and *boat* (<botte>).

Letter-name errors account for 14% of the total errors. The majority of these (59 of 67) occur in the word *party*. The include errors such as <prty>, which involve the representation of the phoneme strings /aɹ/ as <r>, and errors such as <prt> or <part> in which the letter <t> represents the phoneme string /ti:/, as well as errors such as <parte> in which the letter <e> is used to represent phoneme /i:/. The remaining errors occur in the word arm and involve the representation of /ɑːɹ/ with <r> (e.g. <rm>).

Confounding the <a> and <o> vowels accounts for a further 8% of the total errors. The majority of these errors (27 of 41) relate to the substitution of the grapheme <a> representing /ɑ/ with <o> in the words *arm* and *party* (e.g. <orm>, <porty>). Though classified as orthographic, this error is likely to have a phonological basis, as the vowel /a/ can be quite retracted before /r/, and therefore phonetically close to the /ɑ/ phoneme, normally written with <o>. There was just one instance of such a substitution in a non-rhotic context, involving replacement of the grapheme <a> representing /a/ with <o> in the word *tap*. The remaining 13 errors relate to the substitution of long vowel graphemes <oa> in *boat* and <o-e> in *rope* with the grapheme <oo>.

Letter reversals account for a further 3% of the total errors. The majority of these (7 of 13) occur in the word *tap* (<taq>). The remaining errors occur in the words *red* (<reb>), *rope* (<roq>) and *boat* (<dot>).

Errors involving the substitution of a grapheme which represents a similar phoneme in Irish account for 1% of the total errors and occur in words *boat* (<bót>), *rope* (<róp), *arm* (<árm>) and *party* (<partí>). Finally, errors relating to the addition of word final <e> account for 1% of the total and occur in *tap* (<tappe>), *arm* (<arme>) and *sink* (<sinke>).

Table 47

English spelling errors: number and percentage of total errors per category

	Target spelling									
	Red	**Tap**	**Arm**	**Party**	**Rope**	**Boat**	**Mess**	**Sink**	**Total**	**%**
Phonological										
Voicing	2	1		3		1			**7**	**1**
Unstressed vowels									**n/a**	
Cluster			9	9				24	**42**	**9**
Phonological-orthographic										
Unexplained	11	2	7	8	7	5	10	6	**56**	**11**
Long-short vowels					42	35			**77**	**16**
Consonant marker									**n/a**	
Séimhiú									**n/a**	
Orthographic										
Vowels a/o		1	18	9	6	7			**41**	**8**
Letter name			8	59					**67**	**14**
Alternative grapheme (EN)			1	7	5	23		61	**97**	**20**
Alternative grapheme (GA)			1	1	2	2			**6**	**1**
Letter reversal	3	7			1	2			**13**	**3**
Geminates	1	1		8		1	64		**75**	**15**
Final -e		1	3					2	**6**	**1**
Total	17	13	47	104	63	76	74	93	**487**	

7.3.4 Spelling errors related to phonemic awareness errors

The most common error in Irish was the omission of the vowels marking consonant quality, accounting for 143 errors (26% of the total). Distinguishing between velarised and palatalised consonants and between long and short vowels are the two issues identified from the Irish Phoneme Matching task; together these errors account for 36% of the total errors made in the Spelling task.

The most common error in English was use of an alternative phonologically-plausible grapheme, accounting for 97 errors (20% of the total); this indicates good phonological awareness and results from complexity in English orthography. Errors relating to the long-short vowels were the most common phonologically-implausible error, accounting for 77 errors (16% of the total); this was the main issue identified in the English Phoneme Matching task

The absolute number of errors made in relation to long and short vowels is 55 in Irish and 77 in English. The higher number in English may be due to the more complex way in which long vowels are typically represented in English (using a digraph as in *boat* or context-dependent spelling rule as in *rope*) compared to Irish orthography (using an acute accent).

7.4 Chapter summary

The effect of orthographical representations on responses to the Phoneme Matching task and Phoneme Deletion task was first examined. An asymmetric result was obtained in relation to Phoneme Matching; orthographic opacity in the matching condition (different grapheme, same phoneme) did not affect performance whereas opacity in the mismatching condition (same grapheme, different phoneme) did. This is of particular interest as it mirrors the condition of the velarised-palatalised consonants in Irish.

An orthographic effect was also evident on the Phoneme Deletion task; the majority of Grade 2 participants used a phonological strategy while the majority of Grade 3 participants used an orthographic strategy. Furthermore, participants who used an orthographic strategy in Grade 2 had significantly higher Word Reading scores than those who used a phonological strategy, and those who used an orthographic strategy in Grade 3 had higher median scores in Word Reading and Spelling in Grade 3 in both Irish and English than those who used a phonological strategy, though this was not statistically significant.

Finally, an analysis of spelling errors was conducted. This analysis revealed a small number of errors with a basic phonological explanation in each language (accounting for 11% of the total errors in Irish and 10% in English). There were more orthographic errors in English

than in Irish (accounting for 35% of the total errors in Irish and 62% in English). The most common error in English was the substitution of a grapheme with a phonologically plausible alternative, indicating accurate PA and an awareness of phoneme-grapheme rules.

The most common error in Irish was the omission of vowels marking (velarised/palatalised) consonant quality, reflecting the results of the low accuracy items in the Phoneme Matching task. Substitution of a long vowel grapheme for a short one, or vice versa, accounted for a further 10% of the errors. In English, substitution of a short vowel grapheme for a long one accounted for 16% of errors, and was the most common phonologically-implausible error made on the Phoneme Matching task.

CHAPTER 8

RESULTS: PREDICTORS OF LITERACY ATTAINMENT

This chapter details the results that pertain to the sixth research question. Hierarchical Regression Analysis was used to examine the predictors of literacy attainment in Irish and English. The decisions made in relation to data preparation for the regression analysis are outlined in § 8.1, along with the descriptive statistics and correlation matrix relating to the variables included in the analysis. Then, separate regression analyses results are reported for Grade 2 Irish Word Reading (§ 8.2), Grade 3 Irish Word Reading (§ 8.3), Grade 3 Irish Spelling (§ 8.4), Grade 3 English Word Reading (§ 8.5) and Grade 3 English Spelling (§ 8.6). These results provide an indication of how well the phonological and cognitive variables predict literacy attainment in Grade 2 and 3 participants, as well as the relative strength of individual predictors. Finally, an overall summary of findings of all the regression analyses is presented in § 8.7.

8.1 Preparation for hierarchical regression analysis

The decisions made during the data preparation process are reported in this section. In the case of each Hierarchical Regression Analysis (HRA), the data was prepared as described in § 8.1.1 and then evaluated separately to examine whether it met the assumptions necessary to conduct a regression analysis, outlined in § 8.1.2. Descriptive statistics and the correlation matrix of variables are reported in § 8.1.3 and § 8.1.4 respectively. These statistics pertain to the aggregate sample (both GT and GS groups), as the number of participants in the GT sample would not be sufficient in order to conduct separate multiple regression analyses[50].

8.1.1 Data preparation

The data preparation process involved identifying outliers, recoding categorical variables into dummy variables and deciding on the order in which the variables would be entered into the HRA. Each of these steps are detailed below.

Outliers. Cook's D was used to identify prediction outliers. This method uses standardised residuals to measure how much influence a given data point has on the regression coefficients collectively (Aguinis, Gottfredson, Joo, 2013). The cut-off used for

[50] The common rule of thumb is 10 participants for each predictor variable (e.g. 7 predictor variables x 10 participants = minimum of 70 participants), though other formulas have also been developed for calculating sample size based on the expected R^2 (amount of variance in the dependent variable accounted for by the predictor variables) of the analysis (Maxwell, 2000).

Cook's D was 0.1, and the analysis showed that there was one outlier above the cut-off in the HRA with Grade 2 Irish Word Reading as a dependent variable and one outlier in the HRA with Grade 3 Irish Word Reading as a dependent variable. In each case, the outlier was removed from the analysis, this resulted in one less participant in each analysis (there were a total of 115 Grade 2 participants and 124[51] Grade 3 participants including outliers).

Dummy variables. Categorical variables (sex, pre-school language and school) were recoded into dummy variables. Dummy coding recodes a categorical variable into multiple categories: category membership is indicated by a value of 1 in the new category. For example, the variable 'pre-school language' is recoded into two variables: 'pre-school language = Irish' and 'pre-school language = English'. In the case of a participant who went to an Irish-medium pre-school, the variable 'pre-school language = Irish' has a value of 1; the variable 'pre-school language = English' has a value of 0. The standardised regression coefficients for the dummy variables of sex and pre-school language can be interpreted in the same way as those of continuous variables, as there are just two possibilities in each category (male and female for sex; Irish and English for pre-school language[52]). However, the regression coefficients for school, recoded into dummy variables cannot.

For a continuous variable (e.g. RAN score), the B coefficient is the change in the criterion (dependent) variable associated with a unit change in the predictor variables when all other predictor variables are held constant. For a categorical variable, it is the average difference in the intercept between the reference group category (e.g. female) and the comparison group category (e.g. male). The β coefficient is a standardised coefficient; it is the change in the criterion variable associated with a 1 standard deviation (SD) change in the predictor variable, measured in units of the predictor variable's SD. As it is standardised, it allows for direct comparison between predictor variables. The t-test and significance value indicates whether the regression coefficient is significantly different to 0.

In relation to the dummy variable school, if School A is the reference category, the regression coefficient for School B is the average difference in the intercept between the two schools. The coefficients are not reported for individual schools as (i) there are ethical issues surrounding the comparison of data from different schools (ii) this matter is not of interest in this study and (iii) as data collection was not carried out at the same time in each

[51] Note that one participant in the Grade 3 group completed the Irish tasks but not the English tasks, and so was exlcuded from this analysis

[52] There were a small number of participants who completed pre-school education in a language other than Irish. In this case both of the dummy variables within the category pre-school language have a value of 0.

school the data would be expected to vary as a function of the period of the school year it was collected in.

Order of entry. In this study, demographic variables are entered in the first block. These include age (in months), and sex (female is the reference category). The first block also includes two language-related variables attained from the background questionnaire. The first is frequency of parental communication[53] in Irish (for models predicting Irish Word Reading/Spelling) or English (for models predicting English Word Reading/Spelling). The other is the language of pre-school education; Irish is the reference category when the dependent variable is Irish Word Reading or Spelling, while English is the reference category when the dependent variable is English Word Reading or Spelling.

The second block includes the school variable, recoded into dummy variables. Though the regression coefficients for individual schools are not reported, including the school variable as a separate block allows for an estimation of the overall amount of variance accounted for by school. As previously mentioned, this variable would reflect not just school-related characteristics (e.g. socio-economic status, ethos) but also the time difference between data collection in schools.

The third block includes the predictor variables in the language of the dependent variable (i.e. Irish Phoneme Matching, Phoneme Deletion, RAN, Forward Word Span and Productive Vocabulary when predicting Word Reading in Irish). The fourth block includes predictor variables in the other language (English, in this example).

8.1.2 Assumptions of hierarchical regression analysis

In the case of each HRA, the data was carefully examined to investigate whether it met the assumptions necessary to carry out such an analysis. Each of these assumptions is outlined below.

Linearity. A linear relationship between each of the independent variables (e.g. RAN) and the dependent variable (e.g. Word Reading) is assumed in HRA. For each of the five HRAs reported in this chapter, the data met the assumption of linearity between independent variables and the dependent variable, both collectively (as evaluated by a visual inspection of studentised residuals and unstandardised predicted values) as well as

[53] This is a composite value of parents' self-reported responses in the background survey to their frequency of communication in Irish and English. In the case of two-parent responses, the value was an average of both resposes. In the case of one-parent responses, the value is the absolute value of the response. The 5-point scale was inverted in order to be more intuitively interpreted in the regression analysis; the higher the value, the more communication in Irish.

individually (as evaluated by visual inspection of partial regression plots for each independent variable [e.g. RAN] and the dependent variable [e.g. Word Reading]).

Normally-distributed residuals. The data met the assumption that the residuals were normally distributed, as evaluated by visual inspection of a Q-Q plot of the studentised residuals and confirmed by a Shapiro-Wilk (1965) test of normality. The Shapiro-Wilk test assesses the null hypothesis that the sample comes from a normally-distributed population; if the associated p-value is above 0.05, the null hypothesis is not rejected. As demonstrated in the left-hand columns of Table 48, the p-value for the residuals of each of the five HRAs conducted is above 0.05, indicating that the residuals are normally-distributed.

Multicollinearity. Initial models violated the assumption of multicollinearity. Multicollinearity can result in less reliable results, as a small change in a data set can result in spurious changes in the coefficients (e.g. Alin, 2010). Variables with high Variance Inflation Factors (>.4; Winter, 2019) were examined and the correlations between independent variables were then examined. Parents/guardians native language was excluded from the model as it was highly correlated with school. Initial models also included Phoneme Deletion in both languages, but as they were highly correlated this introduced multicollinearity to the model. As a result, Phoneme Deletion was only included in the language of the dependent variable in the models. After these changes, all of the variables included had a low VIF value (below 3.0).

Homoscedasticity. Homoscedasticity is present if the error term is the same for all values of the independent variable; if data is homoscedastic, the data points are scattered approximately the same distance from the regression line (Lane, 2003). An inspection of a scatter plot of studentised residuals and unstandardised predicted values computed for each regression analysis showed that data was homoscedastic. This was further confirmed by the Breusch-Pagan (1979) Test; which tests the null hypothesis that the data is homoscedastic. As demonstrated in the right-hand columns in Table 48, the p-value was above 0.05 for each of the five HRAs conducted, meaning that the null hypothesis of homoscedasticity could not be rejected.

Table 48
Results of Shapiro-Wilk test of normality and Breusch-Pagan test of homoscedasticity for each of the Hierarchical Regression Analyses

	Shapiro-Wilk test of normality		Breusch-Pagan test of homoscedasdicity	
Analysis	Statistic	p-value	Statistic	p-value
Grade 2: Irish Word Reading	.984	.195	.628	.428
Grade 3: Irish Word Reading	.994	.878	.008	.927
Grade 3: Irish Spelling	.983	.121	.112	.738
Grade 3: English Word Reading	.992	.713	.127	.721
Grade 3: English Spelling	.988	.340	.003	.955

8.1.3 Descriptive statistics

The mean, standard deviation, maximum and minimum score for each task is delineated in Table 49. These values are provided in order to allow the reader to interpret the B coefficients reported in the HRAs. As previously mentioned, the B coefficient corresponds to the change in the dependent variable (e.g. Word Reading) which occurs due to a 1-unit increase in the value of the independent variable. For example, if the B coefficient of Phoneme Deletion is 0.5, this indicates that a single point increase in Phoneme Deletion score (e.g. from a score of 8 to a score of 9) results in an increase of 0.5 in Word Reading score (e.g. from a score of 20 words read accurately, to 20.5 words read accurately). The standard deviation and range are also provided to allow for interpretation of these coefficients in the context of participants' scores. A thorough discussion of these values is not provided here, as median values for each of the variables were discussed in detail in Chapter 5.

Table 49
Descriptive statistics for Hierarchical Regression Analyses: maximum score, mean score, standard deviation and range for each task.

	No. of participants	Max. score for task	Mean score for task	Std. Deviation	Range
Grade 2					
Phoneme Matching (GA)	115	24	17.24	2.508	9-22
Phoneme Matching (EN)	115	24	18.97	2.727	11-24
Phoneme Deletion (GA)	115	12	7.30	4.226	0-12
Phoneme Deletion (EN)	115	12	7.43	3.884	0-12
RAN (GA)	115	n/a	60.44	21.610	31-148
RAN (EN)	115	n/a	57.37	18.752	29-127
Forward Word Span (GA)	115	8	5.31	1.353	3-8
Forward Word Span (EN)	115	8	5.42	1.147	4-8
Productive vocab (GA)	115	45	37.04	4.971	17-45
Word Reading (GA)	115	20	10.84	6.469	0-20
Grade 3					
Phoneme Matching (GA)	125	24	17.95	2.268	9-22
Phoneme Matching (EN)	124	24	19.61	2.508	10-24
Phoneme Deletion (GA)	125	12	9.31	2.866	1-12
Phoneme Deletion (EN)	125	12	9.37	3.179	0-12
RAN (GA)	125	n/a	55.76	17.490	29-123

RAN (EN)	124	n/a	49.00	16.439	24-140
Forward Word Span (GA)	125	8	5.60	1.326	3-8
Forward Word Span (EN)	124	8	5.89	1.375	3-8
Productive vocab (GA)	125	45	36.57	4.395	25-45
Word Reading (GA)	125	40	24.52	12.549	0-40
Word Reading (EN)	124	40	23.60	13.451	1-40
Spelling (GA)	125	8	4.05	2.314	0-8
Spelling (EN)	124	8	3.94	2.316	0-8

8.1.4 Correlation matrix

A matrix of Pearson correlations between predictor and literacy variables is presented in Table 50 and Table 51 to demonstrate the relationship between scores on various tasks in Grade 2 and Grade 3 respectively. Note that the correlations reported here differ slightly from those in § 6.2, which pertain to an aggregate Grade 2 and Grade 3 sample. Note that in Table 50 and Table 51, weak correlations are highlighted in light green, moderate correlations in mid-green and strong correlations in dark green. Correlations are interpreted following Schober and colleagues (2018), as described in § 6.2.

Grade 2: correlations between scores on Irish and English predictor tasks. Irish Phoneme Matching and English Phoneme Matching scores are moderately correlated, as are Irish and English RAN and Irish and English Forward Word Span scores. Irish and English Phoneme Deletion scores are strongly correlated.

Grade 2: correlations between scores on predictor tasks. The majority of correlations between the predictor tasks are weak, though there are moderate correlations between Phoneme Matching and Phoneme Deletion scores, as well as between Phoneme Deletion scores (in both languages) and Irish RAN[54]. There is also a moderate correlation

[54] Note that correlations between RAN and other predictor tasks are negative as a lower RAN score indicates a faster naming speed; as such, lower scores indicate better performance.

between Irish RAN and Irish Productive Vocabulary scores. Forward Word Span scores share weak correlations with those of other predictors.

Grade 2: correlations between scores on predictor tasks and literacy tasks. Irish Phoneme Deletion scores are strongly correlated with Irish Word Reading scores. English Phoneme Matching, English Phoneme Deletion, Irish RAN and Irish Productively vocabulary scores are all moderately correlated with Irish Word Reading scores. In contrast, Irish Phoneme Matching, English RAN, English Forward Word Span and Irish Forward Word Span scores are weakly correlated with Irish Word Reading.

Table 50

*Pearson Correlations between predictor variables and Grade 2 Irish Word Reading. Note: light green cells indicate a weak correlation, mid-green cells indicate a moderate correlation, dark green cells indicate a strong correlation and white cells (with the exception of those labelled '1') indicate a negligible correlation. .**Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level.*

	1	2	3	4	5	6	7	8	9	10
1.Phoneme Matching (English)	1	.594**	.449**	.439**	-0.105	-.346**	0.156	0.155	.373**	.432**
2. Phoneme Matching (Irish)	.594**	1	.357**	.345**	-0.079	-.316**	0.066	0.121	.281**	.306**
3. Phoneme Deletion (English)	.449**	.357**	1	.863**	-.335**	-.474**	.317**	.237*	.384**	.666**
4. Phoneme Deletion (Irish)	.439**	.345**	.863**	1	-.397**	-.428**	.230*	.206*	.353**	.733**
5 RAN Objects (English)	-0.105	-0.079	-.335**	-.397**	1	.454**	-.210*	-0.158	-0.125	-.226*
6. RAN Objects (Irish)	-.346**	-.316**	-.474**	-.428**	.454**	1	-0.165	-0.122	-.525**	-.492**
7. Forward Word Span (English)	0.156	0.066	.317**	.230*	-.210*	-0.165	1	.397**	0.175	.274**
8. Forward Word Span (Irish	0.155	0.121	.237*	.206*	-0.158	-0.122	.397**	1	0.159	.300**
9. Productive Vocabulary (Irish)	.373**	.281**	.384**	.353**	-0.125	-.525**	0.175	0.159	1	.516**
10. Word Reading (Irish)	.432**	.306**	.666**	.733**	-.226*	-.492**	.274**	.300**	.516**	1

Grade 3: correlations between scores on Irish and English predictor tasks. Irish Phoneme Matching and English Phoneme Matching scores are moderately correlated, as are Irish and English RAN and Irish and English Forward Word Span scores. In contrast,

Irish and English Phoneme Deletion scores are strongly correlated. This pattern mirrors that of the Grade 2 data.

Grade 3: correlations between score on predictor tasks. The majority of correlations between scores on the predictor tasks are weak, though there are moderate correlations between Irish Phoneme Matching and Irish Phoneme Deletion scores, as well as between Phoneme Deletion scores (in both languages) and Irish RAN[55]. There is also a moderate correlation between Irish RAN and Irish Productive Vocabulary scores, and Irish Phoneme Deletion and Irish Productive Vocabulary scores. Forward Word Span scores share weak correlations with other predictor tasks.

Grade 3: correlations between scores on predictor tasks and literacy tasks. Irish Phoneme Deletion scores have the strongest correlations with measures of literacy attainment; they are strongly correlated with Irish and English Word Reading scores, and Irish and English Spelling scores. English Phoneme Deletion is also strongly correlated with Irish Word Reading scores, and moderately correlated with English Word Reading and English and Irish Spelling scores.

Overall, the Irish predictor scores appear to have stronger correlation with literacy attainment (in both languages) than the English predictor scores. Irish RAN scores are moderately correlated with scores on each of the measures of literacy attainment, while interestingly, English RAN scores are only weakly correlated with each of these measures. Similarly, while Irish Phoneme Matching scores are moderately correlated with English and Irish Spelling. English Phoneme Matching scores are only weakly correlated with scores on these measures. Irish Forward Word Span scores are moderately correlated with Irish Spelling scores, and weakly correlated with scores on the other measures of literacy attainment; English Forward Word Span scores are weakly correlated with scores on all measures of literacy attainment. Irish Productive Vocabulary scores are moderately correlated with Irish Word Reading and English Spelling scores.

[55] Note that correlations between RAN and other predictor tasks are negative as a lower RAN score indicates a faster naming speed; as such, lower scores indicate better performance.

Table 51

*Pearson Correlations between predictor variables and Grade 3 Word Reading and Spelling. Note: light green cells indicate a weak correlation, mid-green cells indicate a moderate correlation, dark green cells indicate a strong correlation and white cells (with the exception of those labelled '1') indicate a negligible correlation.**Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level.*

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1.Phoneme Matching (English)	1	.430**	.324**	.252**	-0.128	-0.028	0.114	0.091	-0.022	0.126	0.141	0.164	0.174
2. Phoneme Matching (Irish)	.430**	1	.380**	.398**	-0.068	-.213*	0.170	.251**	.248**	.368**	.356**	.405**	.395**
3. Phoneme Deletion (English)	.324**	.380**	1	.821**	-.264**	-.455**	.236**	.186*	.332**	.682**	.719**	.593**	.626**
4. Phoneme Deletion (Irish)	.252**	.398**	.821**	1	-.322**	-.530**	.252**	.247**	.432**	.717**	.782**	.707**	.675**
5 RAN Objects (English)	-0.128	-0.068	-.264**	-.322**	1	.445**	-.254**	-.179*	-.218*	-.304**	-.326**	-.294**	-.277**
6. RAN Objects (Irish)	-0.028	-.213*	-.455**	-.530**	.445**	1	-.189*	-.274**	-.433**	-.552**	-.581**	-.493**	-.511**
7. Forward Word Span (English)	0.114	0.170	.236**	.252**	-.254**	-.189*	1	.510**	.238**	.259**	.271**	.302**	.264**
8. Forward Word Span (Irish	0.091	.251**	.186*	.247**	-.179*	-.274**	.510**	1	.248**	.383**	.390**	.366**	.411**
9. Productive Vocabulary (Irish)	-0.022	.248**	.332**	.432**	-.218*	-.433**	.238**	.248**	1	.383**	.498**	.423**	.393**
10. Word Reading (English)	0.126	.368**	.682**	.717**	-.304**	-.552**	.259**	.383**	.383**	1	.932**	.829**	.797**

11. Word Reading (Irish)	0.141	.356**	.719**	.782**	-.326**	-.581**	.271**	.390**	.498**	.932**	1	.813**	.821**
12. Spelling (English)	0.164	.405**	.593**	.707**	-.294**	-.493**	.302**	.366**	.423**	.829**	.813**	1	.764**
13. Spelling (Irish)	0.174	.395**	.626**	.675**	-.277**	-.511**	.264**	.411**	.393**	.797**	.821**	.764**	1

8.1.5 Interpreting Hierarchical Regression Analyses

This section is intended to aid in the interpretation of the values reported in the HRAs presented in § 8.2 – 8.6. A gloss is provided for the terms abbreviated in the tables in the forthcoming sections. The explanations provided are based mainly on Lane (2003) and Winter (2019)

Abbreviation	**Full name/label**	**Explanation**
B	B coefficient	The B coefficient corresponds to change in the dependent variable (e.g. Word Reading) which occurs due to a 1-unit increase in the value of the independent variable (e.g. Phoneme Deletion) when all other predictors are held constant.
Std. Error	Standard Error	This is a measure of how precise the estimate of the coefficient is, and is similar to a measure of dispersion (e.g. standard deviation, variance). The higher this value is, the less likely the B coefficient will be found to be statistically significant.
β	β coefficient	This is a standardised version of the B coefficient. As it is standardised, it allows for comparison between the coefficients of different predictor variables in order to examine their relative strength.
R^2	R^2	This value indicates how much variation in the dependent variable (e.g. Word Reading) is accounted for by the predictor variables in each model.
Adj. R^2	Adjusted R^2	This is an adjusted version of R^2, which is modified based on the number of predictors in the model. A high number of predictors can lead to spurious increases in the R^2 value, and the adjusted R^2 accounts for this.
SSE	Sum of squared estimate of errors	This is the sum of squares of the residuals. As it estimates the discrepancy between the model and the actual observed values, it provides an indication of the precision of the model.
Δ Adj. R^2	Change in adjusted R^2	This is the change in Adjusted R^2 from one model to the next. It indicates how much of the overall Adjusted R^2 value is accounted for by a given model.
F	F-statistic	These values indicate whether the model accounts for a statistically significant amount of variation in the dependent variable.
P	P-value	

The results of the HRAs are provided in the sections that follow, though it should also be noted that all of the information relevant to answering the research questions is summarised and presented in figures in § 8.7.

8.2 Hierarchical Regression Analysis: predicting Grade 2 Irish Word Reading

A hierarchical multiple regression analysis was conducted to determine if the addition of (i) Phoneme Matching[56], Phoneme Deletion, RAN, Forward Word Span and Productive Vocabulary scores *in Irish* and then (ii) Phoneme Matching, RAN and Forward Word Span scores *in English* improved the prediction of **Grade 2 Irish Word Reading attainment** over and above the demographic and language-related variables. The analysis is presented in Table 52.

The analysis shows that Model 1, containing age, sex, frequency of parental communication (FPC) in Irish and pre-school language was statistically significant (R^2=.12, Adjusted[57] R^2=.09 F (4, 109)=3.65, P = .008). The Adjusted R^2 value indicates that the model accounts for 9% of the variance in Grade 2 Irish Word Reading attainment. Only the regression coefficient of FPC in Irish was statistically significant.

Model 2, in which school was added as a variable, was statistically significant (R^2=.22, Adjusted R^2=.15 F (5, 104)=2.69, P = .025). The adjusted R^2 value indicates that the school variable accounts for an additional 6% of the variance in Grade 2 Irish Word Reading attainment.

Model 3, which included the addition of Phoneme Matching, Phoneme Deletion, RAN, Forward Word Span and Productive Vocabulary scores *in Irish* was statistically significant (R^2=.73, Adjusted R^2 =.69, F (5, 99)=36.59 P = .000). The adjusted R^2 change signifies that the predictor tasks in Irish account for an additional 54% of the variance in Word Reading attainment. The regression coefficients of both Forward Word Span and Phoneme Deletion were statistically significant.

Model 4, which included Phoneme Matching, RAN and Forward Word Span scores *in English* was not statistically significant (R^2=.73, Adjusted R^2 =.69, F (3, 96)=.82, P = .488) and did not account for any additional variance in Irish Word Reading attainment.

---

[56] In order to investigate whether including the amended versions of the Phoneme Matching tasks (versions with omitted stimuli, presented in § 6.4.1) affected the outcome of the HRA, an analysis was conducted with Amended Phoneme Matching instead. This did not result in a higher proportion of variance explained in Model 3 (R2 = .73, Adjusted R2 = .69, F (5, 99) = 36.52), p = 000), or model 4 (R2 = .73, Adjusted R2 = .68 F (3, 96) = .62, p = .699). The regression coefficient for Irish Amended Phoneme Matching (Beta = -.005, p = .926) or English Amended Phoneme Matching (Beta = -.018, p = .806) was not statistically significant in this analysis.

[57] While R^2 represents the amount of variance accounted for in the dependent variable in the *sample*, adjusted R^2 amoung of variance accounted for in the *population*. R^2 tends to increase automatically as additional variables are entered; adjusted R^2 attempts to rectify this by adjusting for the number of independent variables in the model compared to the number of data points.

The regression line – the line that best fits the data – is presented in Figure 63 below in the form of a scatterplot.

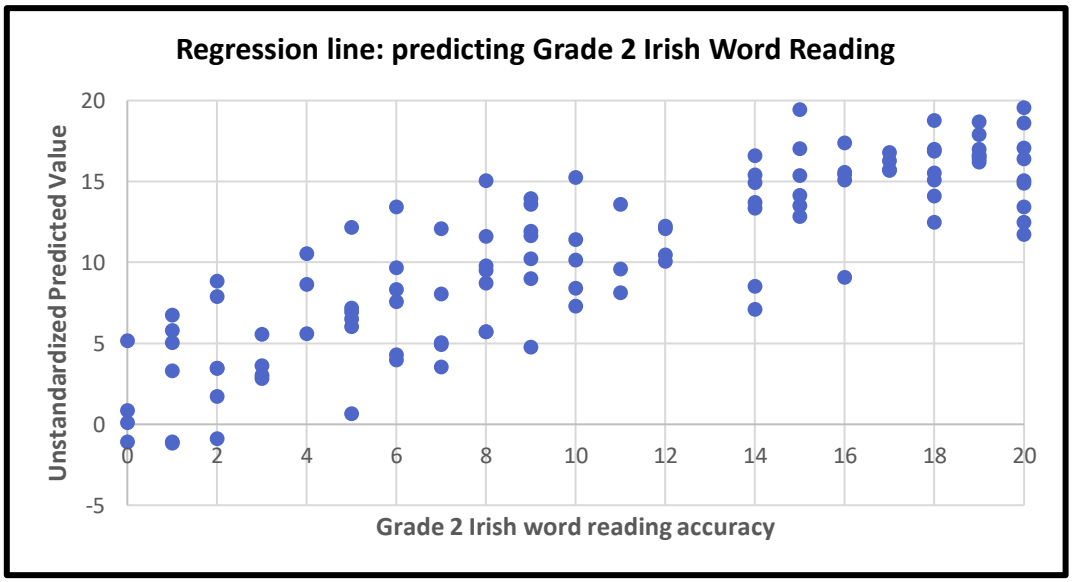

Figure 63 Scatterplot: Regression line of Hierarchical Regression Analysis with Grade 2 Irish Word Reading as the dependent variable

Table 52
Hierarchical Regression Analysis: Grade 2 Irish Word Reading as dependent variable

		B	Std. Error	β	R^2	Adj. R^2	SSE	Δ Adj. R^2	F	P
1	(Constant)	-8.11	11.04		0.12	0.09	6.17	0.09	3.65	.008
	Age	0.25	0.15	0.15						
	FPC Irish	1.60	0.53	.28**						
	PSL Irish	-2.21	1.21	-0.17						
	Sex=Female	-1.65	1.17	-0.13						
2	(Constant)	-0.27	11.09		0.22	0.15	5.94	0.07	2.69	.025
	Age	0.18	0.15	0.11						
	FPC Irish	-1.00	0.61	-0.18						
	PSL Irish	-1.22	1.35	-0.09						
	Sex=Female	-1.26	1.17	-0.10						
	School	-	-	-						
3	(Constant)	-6.12	8.11		0.73	0.69	3.61	0.54	36.59	.000
	Age	0.08	0.09	0.05						
	FPC Irish	-0.67	0.39	-0.12						
	PSL Irish	-0.63	0.83	-0.05						
	Sex=Female	-0.40	0.71	-0.03						
	School	-	-	-						
	Matching (GA)	-0.06	0.16	-0.02						
	RAN (GA)	-0.04	0.02	-0.13						
	Span (GA)	0.62	0.26	.13*						
	Vocabulary (GA)	0.11	0.10	0.09						
	Deletion (GA)	0.93	0.10	.61**						
4	(Constant)	-8.63	8.30		0.73	0.69	3.62	0.00	0.82	.488
	Age	0.08	0.09	0.05						
	FPC Irish	-0.68	0.41	-0.12						
	PSL Irish	-0.67	0.84	-0.05						
	Sex=Female	-0.54	0.72	-0.04						
	School	-	-	-						
	Matching (GA)	-0.16	0.18	-0.06						
	RAN (GA)	-0.05	0.02	-.15*						
	Span (GA)	0.56	0.29	0.12						
	Vocabulary (GA)	0.10	0.11	0.07						
	Deletion (GA)	0.92	0.10	.60**						
	Matching (EN)	0.17	0.18	0.07						
	RAN (EN)	0.02	0.02	0.06						
	Span (EN)	0.25	0.35	0.05						

Note FPC = frequency of parental communication. PSL = Pre-school language. Matching = Phoneme Matching. Deletion = Phoneme Deletion. RAN = Rapid Automatised Naming. Span = Forward Word Span.

8.3 Hierarchical Regression Analysis: predicting Grade 3 Irish Word Reading

A hierarchical multiple regression was conducted to determine if the addition of (i) Phoneme Matching, Phoneme Deletion, RAN, Forward Word Span and Productive Vocabulary scores *in Irish* and then (ii) Phoneme Matching[58], RAN and Forward Word Span scores *in English* improved the prediction of **Grade 3 Irish Word Reading attainment** over and above the demographic and language-related variables. The analysis is presented in Table 53.

The analysis shows that Model 1, containing age, sex, frequency of parental communication in Irish and pre-school language was not statistically significant (R^2=.03, Adjusted R^2= .00 F (4, 118)=.92, P = .454). This indicates that the model does not account for a statistically significant amount of variance in Grade 3 Irish Word Reading.

Model 2, which includes the addition of school as a variable, was statistically significant (R^2=.20, Adjusted R^2=.13 F (5, 113)=4.72, P = .001). The addition of the school variable led to a statistically significant increase in adjusted R^2 of .13, indicating that the school variable accounts for 13% of the variance in Grade 3 Irish Word Reading. None of the regression coefficients were statistically significant.

Model 3, which included the addition of Phoneme Matching, Phoneme Deletion, RAN, Forward Word Span and Productive Vocabulary scores *in Irish* was statistically significant (R^2=.71, Adjusted R^2 =.67, F (5, 108)=38.47 P = .000). The adjusted R^2 change signifies that the predictor tasks in Irish account for an additional 54% of the variance in Grade 3 Irish Word Reading. The regression coefficients of RAN, Forward Word Span and Phoneme Deletion were statistically significant.

Model 4, which included Phoneme Matching, RAN and Forward Word Span scores *in English* was not statistically significant (R^2=.71, Adjusted R^2 =.67, F (3, 105)=.31 P = .816) and did not account for any additional variance in Grade 3 Irish Word Reading

The regression line pertaining to this HRA is presented in Figure 64 below in the form of a scatterplot.

[58] In order to investigate whether including the amended versions of the Phoneme Matching tasks (versions with omitted stimuli, presented in § 6.4.1) affected the outcome of the HRA, an analysis was conducted with Amended Phoneme Matching instea. This did not result in a higher proportion of variance explained in Model 3 (R2 = .71, Adjusted R2 = .67, F (5, 108) = 38.33), p = 000), or model 4 (R2 = .71, Adjusted R2 = .67 F (3, 105) = .29, p = .835). The regression coefficient for Irish Amended Phoneme Matching ((Beta = .022, p = .721) or English Amended Phoneme Matching (Beta = -.005, p = .934) was not statistically significant in this analysis.

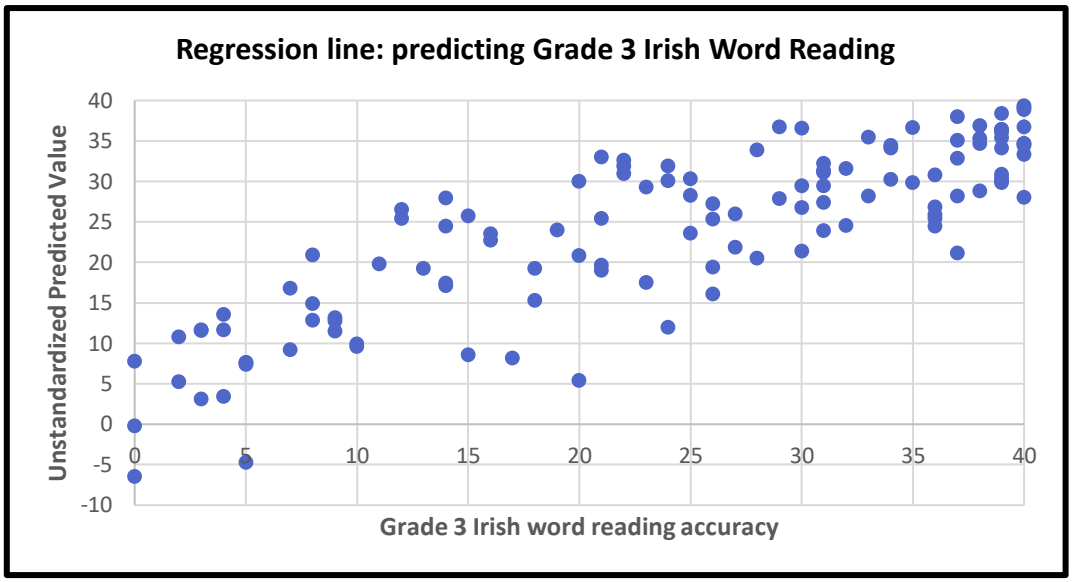

Figure 64 Scatterplot: Regression line of Hierarchical Regression Analysis with Grade 3 Irish Word Reading as the dependent variable

Table 53

Hierarchical Regression Analysis: Grade 3 Irish Word Reading as dependent variable

			Std.					Δ Adj.		
		B	**Error**	**β**	**R^2**	**Adj. R^2**	**SSE**	**R^2**	**F**	**P**
1	(Constant)	9.77	24.60		0.03	0.00	12.61	0.00	0.92	.454
	Age	0.23	0.28	0.08						
	FPC Irish	-1.65	1.07	-0.14						
	PSL Irish	0.38	2.31	0.02						
	Sex=Female	-0.78	2.44	-0.03						
2	(Constant)	-0.60	25.26		0.20	0.13	11.72	0.14	4.72	.001
	Age	0.30	0.28	0.10						
	FPC Irish	-1.77	1.26	-0.15						
	PSL Irish	1.11	2.19	0.04						
	Sex=Female	-3.70	2.58	-0.14						
	School									
3	(Constant)	-9.25	17.76		0.71	0.67	7.19	0.54	38.47	.000
	Age	-0.02	0.18	-0.01						
	FPC Irish	-0.84	0.81	-0.07						
	PSL Irish	0.42	1.39	0.02						
	Sex=Female	-1.97	1.61	-0.08						
	School									
	Matching (GA)	0.21	0.33	0.04						
	RAN (GA)	-0.14	0.05	-.20**						
	Span(GA)	1.29	0.55	.14*						
	Vocabulary (GA)	0.36	0.21	0.12						
	Deletion (GA)	2.28	0.31	.52**						
4	(Constant)	-6.38	18.64		0.71	0.67	7.26	-0.01	0.31	.816
	Age	-0.02	0.19	-0.01						
	FPC Irish	-0.86	0.81	-0.07						
	PSL Irish	0.55	1.43	0.02						
	Sex=Female	-1.79	1.64	-0.07						
	School									
	Matching (GA)	0.26	0.37	0.05						
	RAN (GA)	-0.12	0.05	-.17*						
	Span(GA)	1.46	0.62	.15*						
	Vocabulary (GA)	0.35	0.21	0.12						
	Deletion (GA)	2.28	0.32	.52**						
	Matching (EN)	-0.07	0.30	-0.01						
	RAN (EN)	-0.04	0.05	-0.06						
	Span (EN)	-0.37	0.60	-0.04						

Note FPC = frequency of parental communication. PSL = Pre-school language. Matching = Phoneme Matching. Deletion = Phoneme Deletion. RAN = Rapid Automatised Naming. Span = Forward Word Span.

8.4 Hierarchical regression analysis: predicting Grade 3 Irish Spelling

A hierarchical multiple regression was conducted to determine if the addition of (i) Phoneme Matching, Phoneme Deletion, RAN Forward Word Span and Productive Vocabulary scores *in Irish* and then (ii) Phoneme Matching[59], RAN and Forward Word Span scores *in English* improved the prediction of **Grade 3 Irish Spelling** over and above the demographic and language-related variables. The analysis is presented in Table 54.

The analysis shows that Model 1, containing age, sex, frequency of parental communication in Irish and pre-school language was not statistically significant (R^2=.02, Adjusted R^2= -.01, F (4, 119)=.58, P = .677). The model does not account for a statistically significant amount of variance in Grade 3 Irish Spelling. Note that a negative adjusted R^2 means this model is worse than the null model, described in § 5.8.4.

Model 2, which includes the addition of school as a variable, was statistically significant (R^2=.23, Adjusted R^2=.17 F (5, 114)=6.25, P = .000). The addition of the school variable led to a statistically significant increase in adjusted R^2 of .17, indicating that the school variable accounts for 17% of the variance in Grade 3 Irish Spelling.

Model 3, which included the addition of Phoneme Matching, Phoneme Deletion, RAN, Forward Word Span and Productive Vocabulary scores *in Irish* was statistically significant (R^2=.62, Adjusted R^2 =.57, F (5, 109)=22.22 P = .000). The adjusted R^2 change signifies that the predictor tasks in Irish account for an additional 40% of the variance in Grade 3 Irish Spelling. The regression coefficients of Phoneme Matching, RAN, Forward Word Span and Phoneme Deletion were statistically significant.

Model 4, which included Phoneme Matching, RAN and Forward Word Span scores *in English* was not statistically significant (R^2=.62, Adjusted R^2 =.56, F (3, 106)=.24 P = .869) and did not account for any additional variance in Grade 3 Irish Spelling.

[59] In order to investigate whether including the amended versions of the Phoneme Matching tasks (versions with omitted stimuli, presented in § 6.4.1) affected the outcome of the HRA, an analysis was conducted with Amended Phoneme Matching instead. This did not result in a higher proportion of variance explained in Model 3 (R2 = .62, Adjusted R2 = .57, F (5, 109) = 22.45), p = 000), or model 4 (R2 = .62, Adjusted R2 = .56 F (3, 106) = .22, p = .882). The regression coefficient for Irish Amended Phoneme Matching was statistically significant (Beta = .16, p = .021), while the English Amended Phoneme Matching (Beta = -.005, p = .945) was not statistically significant; this coincides with the results in Table 54.

The regression line pertaining to this HRA is presented in Figure 65 below in the form of a scatterplot.

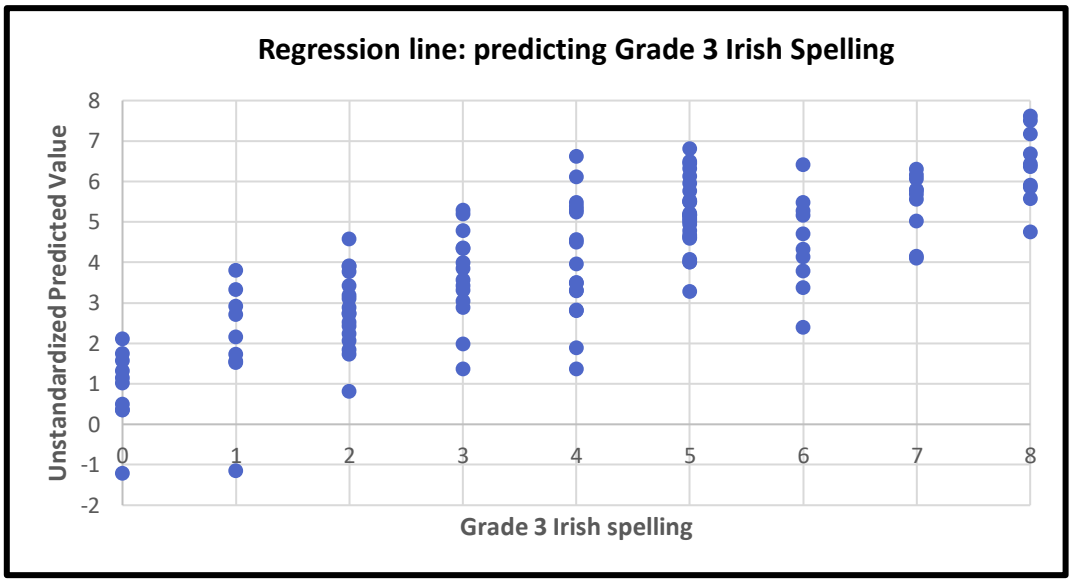

Figure 65 Scatterplot: Regression line of Hierarchical Regression Analysis with Grade 3 Irish Spelling as the dependent variable

Table 54
Hierarchical Regression Analysis: Grade 3 Irish Spelling as dependent variable

			Std.					Δ Adj.		
		B	**Error**	**β**	**R^2**	**Adj. R^2**	**SSE**	**R^2**	**F**	**P**
1	(Constant)	4.37	4.55		0.02	-0.01	2.34	-0.01	0.58	.677
	Age	0.01	0.05	0.01						
	FPC Irish	-0.28	0.20	-0.13						
	PSL Irish	0.01	0.43	0.00						
	Sex=Female	-0.10	0.45	-0.02						
2	(Constant)	2.09	4.56		0.23	0.17	2.12	0.18	6.25	.000
	Age	0.02	0.05	0.04						
	FPC Irish	-0.29	0.23	-0.14						
	PSL Irish	0.10	0.39	0.02						
	Sex=Female	-0.73	0.47	-0.15						
	School	-	-	-						
3	(Constant)	2.13	3.77		0.62	0.57	1.52	0.39	22.22	.000
	Age	-0.05	0.04	-0.09						
	FPC Irish	-0.19	0.17	-0.09						
	PSL Irish	0.02	0.29	0.00						
	Sex=Female	-0.56	0.34	-0.12						
	School	-	-	-						
	Matching (GA)	0.16	0.07	.15*						
	RAN (GA)	-0.03	0.01	-.22**						
	Span(GA)	0.35	0.12	.20**						
	Vocabulary (GA)	0.02	0.04	0.05						
	Deletion (GA)	0.27	0.07	.33**						
4	(Constant)	2.54	3.96		0.62	0.56	1.54	0.01	0.24	0.869
	Age	-0.05	0.04	-0.09						
	FPC Irish	-0.19	0.17	-0.09						
	PSL Irish	0.04	0.30	0.01						
	Sex=Female	-0.53	0.35	-0.11						
	School	-	-	-						
	Matching (GA)	0.16	0.08	.16*						
	RAN (GA)	-0.03	0.01	-.20*						
	Span(GA)	0.38	0.13	.22**						
	Vocabulary (GA)	0.02	0.05	0.04						
	Deletion (GA)	0.26	0.07	.33**						
	Matching (EN)	0.00	0.07	0.00						
	RAN (EN)	-0.01	0.01	-0.06						
	Span (EN)	-0.07	0.13	-0.04						

Note FPC = frequency of parental communication. PSL = Pre-school language. Matching = Phoneme Matching. Deletion = Phoneme Deletion. RAN = Rapid Automatised Naming. Span = Forward Word Span.

8.5 Hierarchical regression analysis: predicting Grade 3 English Word Reading

A hierarchical multiple regression was conducted to determine if the addition of (i) Phoneme Matching, Phoneme Deletion, RAN and Forward Word Span scores *in English* and then (ii) Phoneme Matching[60], RAN and Forward Word Span scores *in Irish* improved the prediction of **Grade 3 English Word Reading attainment** over and above the demographic and language-related variables. The analysis is presented in Table 55.

The analysis shows that Model 1, containing age, sex, frequency of parental communication in English and pre-school language was not statistically significant (R^2=.07, Adjusted R^2= .04 F (4, 119)=.2.15, P = .079). The adjusted R^2 value indicates that the model accounts for 4% of the variance in English Word Reading attainment. Only the regression coefficient for frequency of parental communication in English was statistically significant.

Model 2, which includes the addition of school as a variable, was statistically significant (R^2=.18, Adjusted R^2=.11 F (5, 114)=3.01, P = .014). The addition of the school variable led to a statistically significant increase in adjusted R^2 of .07, indicating that the school variable accounts for an additional 7% of the variance in Grade 3 English Word Reading.

Model 3, which included the addition of Phoneme Matching, Phoneme Deletion, RAN and Forward Word Span scores *in English* was statistically significant (R^2=.65, Adjusted R^2 =.60, F (5, 109)=36.00 P = .000). The adjusted R^2 change signifies that the predictor tasks in English account for an additional 49% of the variance in Grade 3 English Word Reading. The regression coefficients of RAN and Phoneme Deletion were statistically significant.

Model 4, which included Phoneme Matching, RAN and Forward Word Span scores *in Irish* was statistically significant (R^2=.70, Adjusted R^2 =.65 F (3, 106)=4.85 P = .001). The adjusted R^2 value indicates that the Irish predictor tasks account for an additional 5% of variance in Grade 3 English Word Reading.

The regression line pertaining to this HRA is presented in Figure 66.

[60] In order to investigate whether including the amended versions of the Phoneme Matching tasks (versions with omitted stimuli, presented in § 6.4.1) affected the outcome of the HRA, an analysis was conducted with Amended Phoneme Matching instead. This did not result in a higher proportion of variance explained in Model 3 (R2 = .64, Adjusted R2 = .60, F (5, 109) = 35.67, p = 000), or model 4 (R2 = .70, Adjusted R2 = .65 F (3, 106) = 4.68, p = .002). The regression coefficient for English Amended Phoneme Matching (Beta = -.08, p = .191) or Irish Amended Phoneme Matching (Beta = .09, p = .242) was not statistically significant in this analysis.

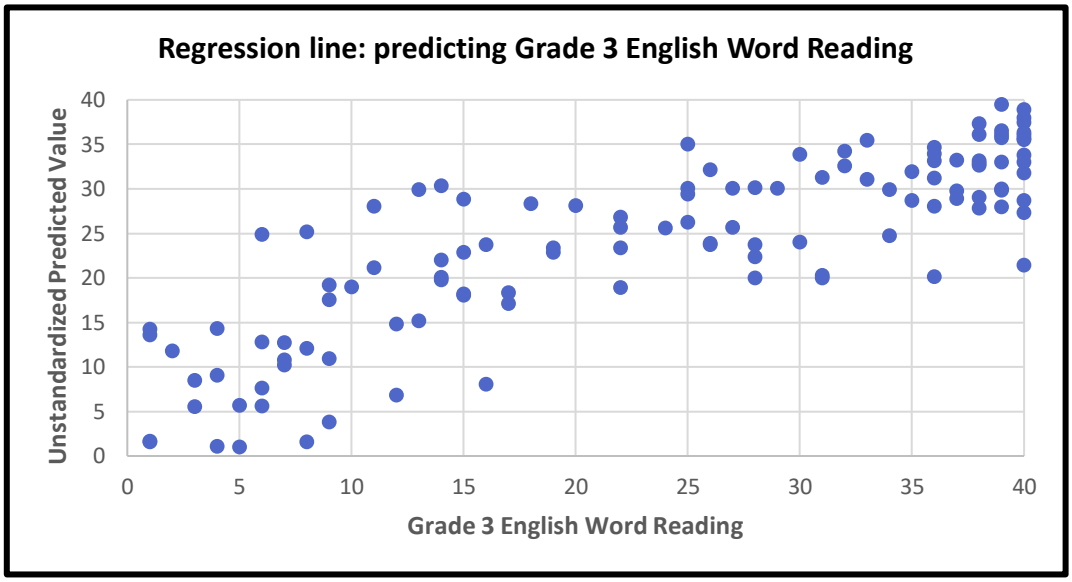

Figure 66 Scatterplot: Regression line of Hierarchical Regression Analysis with Grade 3 English Word Reading as the dependent variable

Table 55

Hierarchical Regression Analysis: Grade 3 English Word Reading as dependent variable

		B	Std. Error	β	R^2	Adj. R^2	SSE	Δ Adj. R^2	F	P
1	(Constant)	10.37	25.75		0.07	0.04	13.25	0.04	2.15	0.079
	Age	0.10	0.30	0.03						
	FPC English	2.97	1.14	.239*						
	PSL English	-2.01	2.42	-0.07						
	Sex=Female	0.45	2.52	0.02						
2	(Constant)	-13.44	27.72		0.18	0.11	12.72	0.08	3.01	0.014
	Age	0.31	0.32	0.09						
	FPC English	2.57	1.35	0.21						
	PSL English	-1.44	2.37	-0.05						
	Sex=Female	1.85	2.90	0.07						
	School									
3	(Constant)	-22.34	19.81		0.65	0.60	8.50	0.49	36.00	0.00
	Age	0.34	0.21	0.10						
	FPC English	1.18	0.92	0.09						
	PSL English	-1.97	1.61	-0.07						
	Sex=Female	-0.11	2.01	0.00						
	School									
	Matching (EN)	-0.50	0.33	-0.09						
	RAN (EN)	-0.17	0.06	-.205**						
	Span (EN)	0.92	0.61	0.09						
	Deletion (EN)	2.79	0.31	.631**						
4	(Constant)	-8.42	20.74		0.70	0.65	7.96	0.05	4.85	0.00
	Age	0.01	0.22	0.00						
	FPC English	0.69	0.96	0.06						
	PSL English	-2.22	1.56	-0.08						
	Sex=Female	0.09	1.91	0.00						
	School									
	Matching (EN)	-0.55	0.34	-0.10						
	RAN (EN)	-0.08	0.06	-0.10						
	Span (EN)	-0.04	0.67	0.00						
	Deletion (EN)	2.32	0.32	.53**						
	Matching (GA)	0.65	0.42	0.11						
	RAN (GA)	-0.13	0.06	-.17*						
	Span (GA)	1.22	0.70	0.12						
	Vocabulary (GA)-	0.30	0.24	0.10						

Note FPC = frequency of parental communication. PSL = Pre-school language. Matching = Phoneme Matching. Deletion = Phoneme Deletion. RAN = Rapid Automatised Naming. Span = Forward Word Span..

8.6 Hierarchical Regression analysis: predicting Grade 3 English Spelling

A hierarchical multiple regression was conducted to determine if the addition of (i) Phoneme Matching, Phoneme Deletion, RAN and Forward Word Span scores *in English* and then (ii) Phoneme Deletion[61], RAN and Forward Word Span *in Irish* improved the prediction of **Grade 3 English Spelling** over and above the demographic and language-related variables. The analysis is presented in Table 56.

The analysis shows that Model 1, containing age, sex, frequency of parental communication in English and pre-school language was statistically significant (R^2=.10, Adjusted R^2= .07 F (4, 119)=.3.28, P = .014). The adjusted R^2 value indicates that the model accounts for 7% of the variance in Grade 3 English Spelling. Only the regression coefficient for frequency of parental communication in English was statistically significant.

Model 2, which includes the addition of school as a variable, was statistically significant (R^2=.20, Adjusted R^2=.14 F (5, 114)=3.00, P = .014). The addition of the school variable led to a statistically significant increase in adjusted R^2 of .07, indicating that it accounts for an additional 7% of the variance in Grade 3 English Spelling.

Model 3, which included the addition of Phoneme Matching, Phoneme Deletion, RAN and Forward Word Span scores *in English* was statistically significant (R^2=.55, Adjusted R^2 =.50, F (5, 109)=21.01 P = .000). The adjusted R^2 change signifies that the predictor tasks in English account for an additional 36% of the variance in Grade 3 English Spelling. The regression coefficients of RAN, Forward Word Span and Phoneme Deletion were statistically significant.

Model 4, which included Phoneme Matching, RAN and Forward Word Span scores *in Irish* was statistically significant (R^2=.63, Adjusted R^2 =.57, F (3, 106)=5.76 P = .000). The adjusted R^2 value indicates that the Irish predictor tasks account for an additional 7% of variance in Grade 3 English Spelling.

The regression line pertaining to this HRA is presented in Figure 67.

[61] In order to investigate whether including the amended versions of the Phoneme Matching tasks (versions with omitted stimuli, presented in § 6.4.1) affected the outcome of the HRA, an analysis was conducted with Amended Phoneme Matching instead. This did not result in a higher proportion of variance explained in Model 3 (R2 = .55, Adjusted R2 = .50, F (5, 109) = 21.09), p = 000) and marginally less variance in Model 4 (R2 = .61, Adjusted R2 = .55 F (3, 106) = 4.25, p = .003), compared to the analysis in Table 56. The regression coefficient for English Amended Phoneme Matching (Beta = .03, p = .666) and Irish Amended Phoneme Matching (Beta = .140, p = .085) were not statistically significant in this analysis.

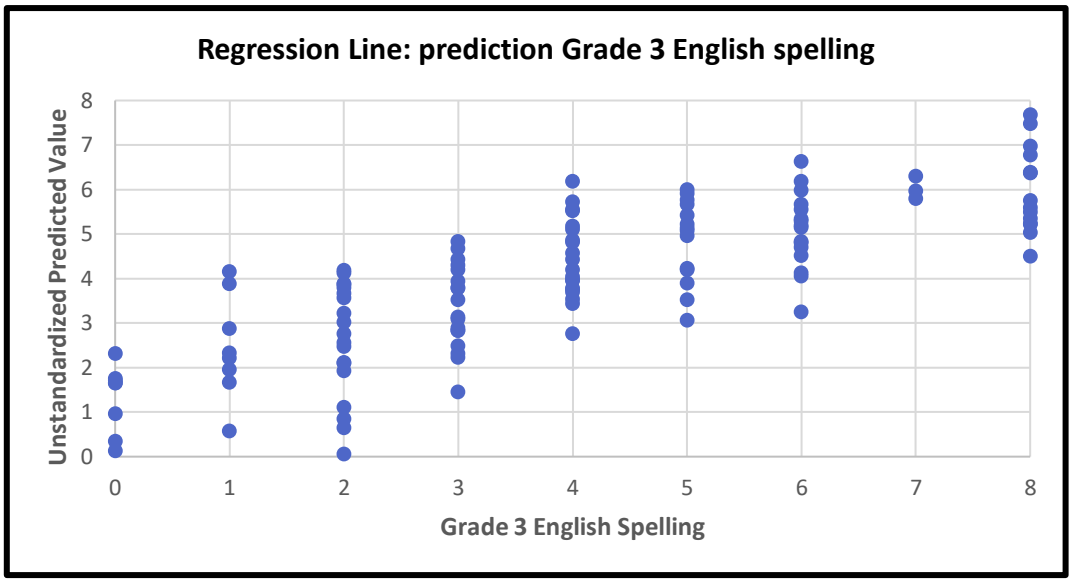

Figure 67 Scatterplot: Regression line of Hierarchical Regression Analysis with Grade 3 English Spelling as the dependent variable

Table 56

Hierarchical Regression Analysis: Grade 3 English Spelling as dependent variable

			Std.					Δ Adj.		
		B	**Error**	**β**	**R^2**	**Adj. R^2**	**SSE**	**R^2**	**F**	**P**
1	(Constant)	7.18	4.28		0.10	0.07	2.23	0.07	3.28	.014
	Age	-0.05	0.05	-0.09						
	FPC English	-0.45	0.41	-0.10						
	PSL English	0.58	0.19	.27**						
	Sex=Female	0.43	0.42	0.09						
2	(Constant)	1.09	4.63		0.20	0.14	2.15	0.07	3.00	.014
	Age	0.01	0.05	0.01						
	FPC English	-0.26	0.40	-0.06						
	PSL English	0.55	0.23	.255*						
	Sex=Female	0.35	0.48	0.08						
	School	1.80	0.56	0.37						
3	(Constant)	-1.59	3.81		0.55	0.50	1.65	0.35	21.01	.000
	Age	0.01	0.04	0.02						
	FPC English	-0.43	0.31	-0.09						
	PSL English	0.39	0.18	0.18						
	Sex=Female	0.23	0.39	0.05						
	School	0.72	0.45	0.15						
	Matching (EN)	-0.01	0.06	-0.01						
	RAN (EN)	-0.03	0.01	-.23**						
	Span (EN)	0.31	0.12	.19**						
	Deletion (EN)	0.33	0.06	.43**						
4	(Constant)	0.97	3.89		0.63	0.57	1.52	0.08	5.76	.000
	Age	-0.06	0.04	-0.10						
	FPC English	-0.48	0.30	-0.10						
	PSL English	0.34	0.18	0.16						
	Sex=Female	0.18	0.36	0.04						
	School	0.81	0.43	0.17						
	Matching (EN)	-0.06	0.07	-0.07						
	RAN (EN)	-0.02	0.01	-0.14						
	Span (EN)	0.14	0.13	0.08						
	Deletion (EN)	0.23	0.06	.30**						
	Matching (GA)	0.24	0.08	.23**						
	RAN (GA)	-0.02	0.01	-0.16						
	Span (GA)	0.20	0.13	0.11						
	Vocabulary (GA)-	0.04	0.05	0.08						

Note FPC = frequency of parental communication. PSL = Pre-school language. Matching = Phoneme Matching. Deletion = Phoneme Deletion. RAN = Rapid Automatised Naming. Span = Forward Word Span.

8.7 Summary

This section provides an overview of the findings obtained in the HRAs. The variance accounted for by each model – an indication of the strength of each models' predictors – is summarised in § 8.7.1 for each HRA. Then, the findings in relation to the relative strength of each predictor are summarised in § 8.7.2.

8.7.1 Variance accounted for by each Model: adjusted R^2 change

The Adjusted R^2 change provides an indication of the amount of variance in the dependent variable (i.e. Word Reading or Spelling) accounted for by the model. The Adjusted R^2 values for each model in each HRA are presented in Table 57.

Table 57
Summary table of Adjusted R^2 of each model in each Hierarchical Regression Analysis

	G2 Irish Word Reading	G3 Irish Word Reading	G3 Irish word Spelling	G3 English Word Reading	G3 English word Spelling
Model 1					
Δ Adjusted R^2	.09**	.00	-.01	.04	.07
Model 2					
Δ Adjusted R^2	.06*	.13**	.17**	.07*	.07
Model 3					
Δ Adjusted R2	.54**	.54**	.40**	.49**	.36**
Model 4					
Δ Adjusted R2	.00	-.01	-.01	.05**	.07**

A visualisation of these values is provided in Figure 68. This provides some indication of how effective each of the models are in predicting literacy. For clarity, the variables included in each model are outlined in Table 58 below:

Table 58
Summary of the variables included in each of the models in the Hierarchical Regression Analyses

Model 1	Demographic and language background variables
Model 2	School variable
Model 3	Cognitive and phonological variables (Phoneme Deletion, Phoneme Matching, RAN, Forward Word Span, Productive Vocabulary) in the language of the dependent variable (e.g. Irish Phoneme Matching when predicting Irish Word Reading accuracy)
Model 4	Cognitive and phonological variables (Phoneme Deletion, Phoneme Matching, RAN, Forward Word Span, Productive Vocabulary) in the other language (e.g. English Phoneme Matching when predicting Irish Word Reading accuracy)

The Adjusted R^2 values show that Model 1 (which includes demographic and language-related variables) is only statistically significant for Grade 2 Irish Word Reading, where it accounts for 9% of the variance. Comparing the outcome of Model 2 in each analysis, the school variable explains more variance in Grade 3 Irish Word Reading and Spelling (13% and 17%, respectively) than in Grade 3 English Word Reading and Spelling (7%) in Grade 3 participants. It appears, from a comparison of the Model 3 analyses, that the predictor tasks explain more variance in Word Reading than in Spelling in both Irish (54% vs 40%) and in English (49% vs 36%) in Grade 3 participants. Finally, it is of note that while the English predictors do not explain any additional variance in Irish Word Reading or Spelling (Model 4 non-significant), the Irish predictors explain 5% of the variance in English Word Reading and 7% of the variance in English Spelling.

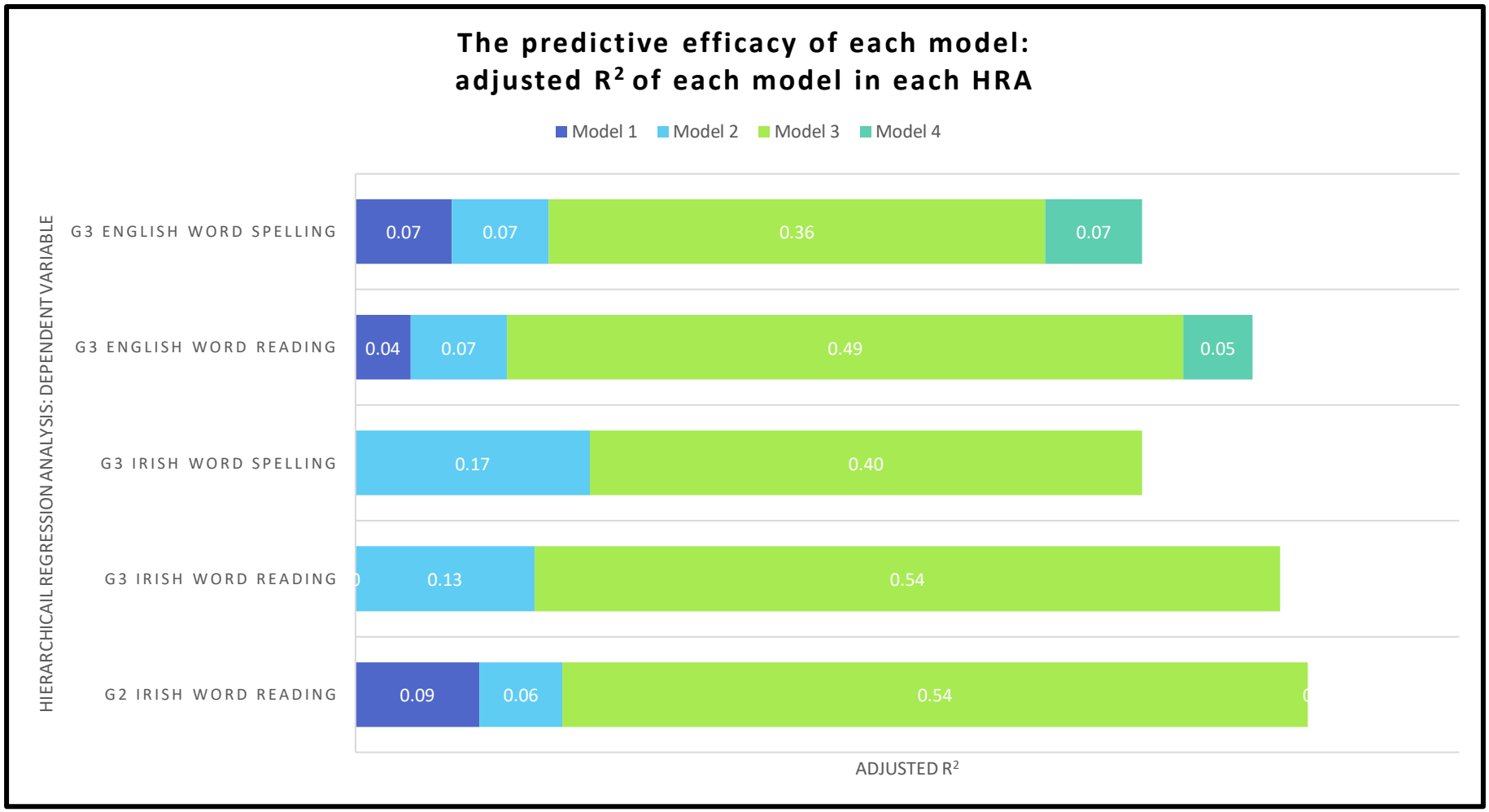

Figure 68 The predictive efficacy of each model: adjusted R^2 of each model in each Hierarchical Regression Analysis

8.7.2 Unique predictors of literacy attainment: β coefficients

The β coefficient allows for an examination of the relative strength of predictor variables. A summary of these values is provided in Table 59.

Table 59
Unique predictors of Grade 2 and Grade 3 Word Reading and Spelling: β coefficients. Note: PM = Phoneme Matching; PD = Phoneme Deletion; FWS = Forward Word Span; PV= Productive Vocabulary.

	Independent variable: Irish					Independent variable: English			
Dependent variable	PM	PD	RAN	FWS	PV	PM	PD	RAN	FWS
G2 Irish Word Reading		.61**		.13*					
G3 Irish Word Reading		.52**	-.20**	.14*					
G3 Irish Spelling	.15*	.33**	-.22**	.20**					
G3 English Word Reading			-.17*				.53**		
G3 English Spelling	.23*						.30**		

Figure 69 provides a visualisation of the data in Table 59. The β coefficients listed pertain to the final model which is statistically significant (i.e. the model that accounts for the most variance in the dependent variable). For the first three analyses (Grade 2 Irish Word Reading; Grade 3 Irish Word Reading; Grade 3 Irish Spelling), this is Model 3. For the final two analyses (Grade 3 English Word Reading; Grade 3 English Spelling), this is Model 4.

Irish Phoneme Deletion was the strongest predictor of Irish Word Reading and Spelling, while English Phoneme Deletion was the strongest predictor of English Word Reading and Spelling. In both languages, Phoneme Deletion explains more variation in Word Reading than in Spelling. Irish Phoneme Matching predicted Irish Spelling and English Spelling in Grade 3, but did not predict Word Reading in any grade. Irish Forward Word Span also predicted Irish Word Reading and Spelling in Grade 2 and 3, while Irish RAN predicted Irish Word Reading and Spelling in Grade 3 only. Interestingly, Irish RAN predicted English Word Reading in Grade 2, and Irish Phoneme Matching predicted English Spelling in Grade 3.

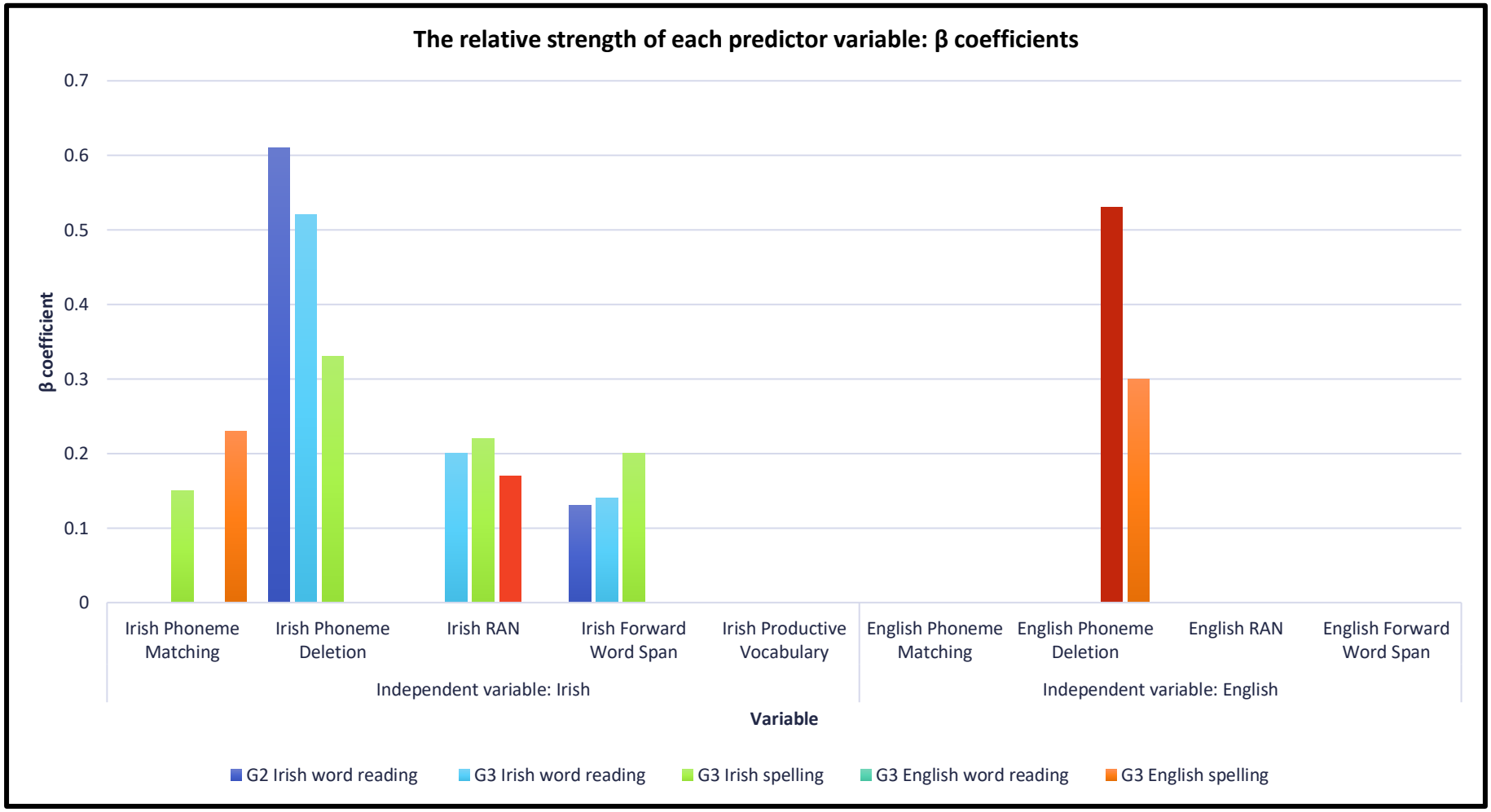

Figure 69 The relative strength of each predictor variable: β coefficients

8.8 Chapter summary

This chapter addressed the sixth research question and investigated the predictors of Word Reading and Spelling in Irish and English. The results of the hierarchical regression analyses indicate that the predictor tasks explain the variance in Word Reading attainment in Irish and English to a similar level (54% and 49% respectively), and somewhat less variance in Spelling in each language (40% of the variance in Irish Spelling; 36% of the variance in English Spelling).

In terms of the relative strength of the predictor variables, Phoneme Deletion explained the most variance in Word Reading and Spelling in each language. Irish Forward Word Span also predicted Irish Word Reading and Spelling to a lesser degree. Irish RAN predicted both Irish and English Word Reading, while Irish Phoneme Matching predicted Spelling in both Irish and English.

CHAPTER 9

DISCUSSION AND CONCLUSIONS

This final chapter provides a brief summary of the overall aims of the thesis and of the findings of previous chapters. The findings pertaining to each research question are discussed, and a number of overarching conclusions made. The implications of these findings are established, and a number of avenues for future work are identified.

9.1 Summary of thesis

The aims of this thesis were to examine (i) which cognitive and phonological abilities predict word reading and spelling in Irish and English (ii) to what extent these abilities are language-universal, as opposed to language-specific and (iii) the nature and validity of one of the constructs; bilingual phonemic awareness. A number of contextual factors were introduced in Chapter 2. In terms of the sociolinguistic context, though English is the dominant majority language in Ireland, Irish is spoken as the language of the community in Gaeltacht areas (though there is a high level of variation between areas in relation to the extent Irish is spoken; Central Statistics Office, 2016). There is also a strong and growing interest in Irish immersion education in urban areas (Gaeloideachas, 2020). The study reported in this thesis included participants from both Gaeltacht schools and Gaelscoileanna. Children in participating schools learn to read in Irish first, and are introduced to English literacy instruction at the end of the second year or start of the third year of schooling. The major features of Irish phonology and orthography differ substantially from those of English (Ní Chasaide et al, 2019; Barnes, 2017).

This study examined phonemic awareness (PA), rapid automatised naming (RAN) and verbal short-term memory (VSTM) as predictors of literacy in Irish and English, as well as Productive Vocabulary in Irish only. An important distinction made in this thesis is between the primarily meta-linguistic component of PA (MPA), and the linguistic component (LPA). The latter component is concerned with the ability to distinguish between the phonemic contrasts of a language, a particularly fundamental skill which would be expected to impact on spelling and reading in that language. A review of previous studies in Chapter 3 indicated that PA has been found to be a stronger predictor of decoding accuracy and spelling, while RAN is a particularly strong predictor of reading speed and fluency (note that these latter components are aspects of reading attainment not investigated in this study). VSTM has been found to be a relatively weak predictor of literacy attainment in comparison to both PA and RAN. With regard to dual-language learners, there are typically differing patterns of predictors in each of their languages. Within-language

predictors appear to be most effective, though cross-language predictors have also been found to be unique predictors (i.e. independent of other predictors) of literacy attainment.

A dual-language battery of tasks was designed in order to examine these predictor skills, as well as literacy attainment, in Irish and English. The design process included an initial selection of tasks based on their suitability and their efficacy as predictors, followed by an iterative process of pre-testing and refining the task format and stimuli. This process was reported in Chapter 4. This task battery was used in a cross-sectional study with 345 participants from Grade 1, 2 and 3 in Gaeltacht schools and Gaelscoileanna. The language background of participants in Gaeltacht schools differed from their peers in Gaelscoileanna, as the vast majority had at least one native Irish-speaking parent and reported higher frequency of communication in Irish. A detailed description of the sampling method, the participants' demographic and language background and the statistical methods used for analyses was reported in Chapter 5.

The results were reported in Chapters 6, 7 and 8 and a discussion of those results follows in the next section.

9.2 Discussion

In this section, the results are discussed in the context of the research questions investigated in this thesis.

RQ1 Do scores for Irish-English bilinguals support the assertion that phonological and cognitive abilities (phonemic awareness, rapid automatised naming, verbal short-term memory) and literacy skills are language-universal?

Overall, the results of this study indicate that these abilities comprise both language-universal and language-specific components. A summary of these components are presented in Figure 70 and described below.

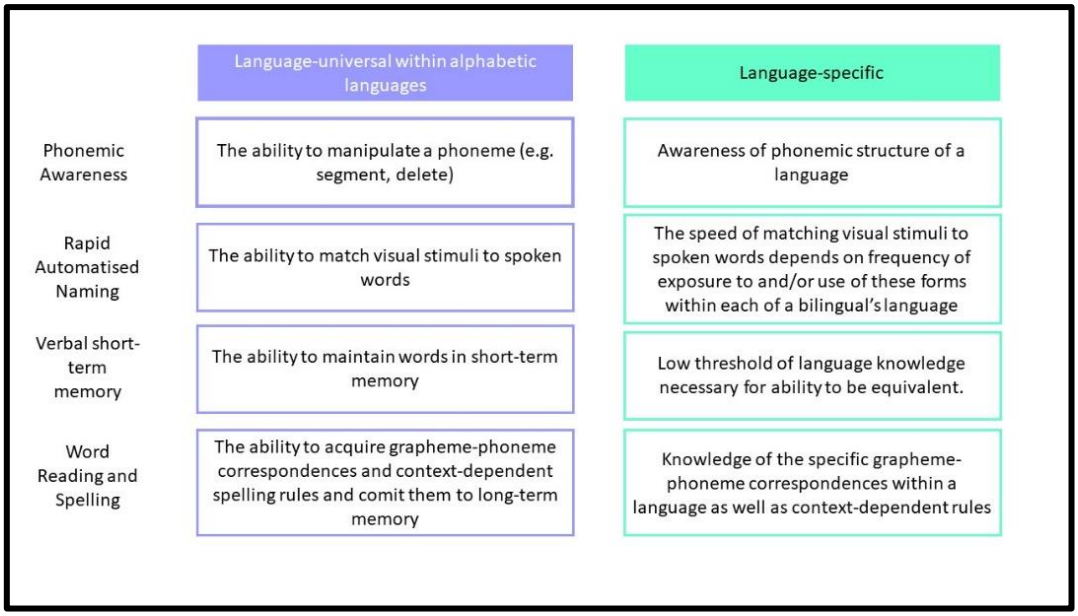

Figure 70 Language-universal and language-specific components of abilities and skills examined in the present thesis

In relation to literacy domains, the results indicate that there was no significant difference between scores in Grade 3 Irish and English Word Reading and Spelling in either the GT or GS group. Given that they had less that one year's experience with English reading instruction, this is consistent with the finding that there is a common underlying proficiency in relation to Irish and English word reading and spelling in Irish-English bilinguals of this age. The language-specific nature of the spelling errors made (discussed in relation to RQ4 below), however, indicate that knowledge pertaining to the grapheme-phoneme correspondences of a given language also plays a major role in literacy acquisition.

In relation to PA, contrasting results were obtained with regard to Phoneme Deletion and Phoneme Matching scores. While there was no significant difference between Irish and English Phoneme Deletion scores (measuring MPA) within each of the GT and GS groups, Phoneme Matching scores (measuring LPA) were significantly higher in English than in Irish in every group except the Grade 1 GT group. This is consistent with Saiegh-Haddad's (2019) conceptualisation of PA: while there is indeed a metalinguistic component to PA which could be expected to be language-universal across a bilingual's languages, there is also a language-specific component to PA which depends on an awareness of the phonemic structure of a given language. The velarised-palatalised consonants of Irish – which have no parallel in English phonology - were largely responsible for the cross-linguistic difference in Phoneme Matching scores.

This indicates a lack of explicit awareness in relation to a fundamental part of the phonemic structure of Irish. Overall, these results suggest that while the ability to manipulate a phoneme is largely language-universal in alphabetic languages, the explicit awareness of

the phonemic structure of a language is language-specific, and is likely to require explicit instruction. Note that this finding does not hold in non-alphabetic languages, such as Arabic (Saiegh-Haddad & Geva, 2008) and Hebrew (Ben-Dror, Frost & Bentin, 1995).

There was a significant difference between Irish and English RAN scores in every grade; the GT group were faster at naming Irish items than English items in every grade, while the GS group were faster at naming English items than Irish items in every grade. Given the language background of each group, this indicates that the speed of mapping visual stimuli to their spoken word forms (as measured by RAN), is significantly lower in a child's non-dominant language. This result is in agreement with the findings of previous studies which suggest that naming speed is significantly lower in a person's non-dominant language (Gollan et al, 2008; Pae et al, 2009). This discrepancy appears to be the result of a frequency effect (Ivanova & Costa, 2008), relating to a person's exposure to or use of a given language. This has implications for literacy screening and assessment; RAN scores obtained in a child's non-dominant language are unlikely to be representative of their ability or comparable to norms for native speakers of the language.

There was no significant difference between Forward Word Span scores in Irish and English in any group except for the Grade 1 GS group who had lower scores in Irish. This would indicate that, given a low threshold level of language knowledge, VSTM is a common cognitive process in each language. It is probable that Forward Word Span scores in an L2, once a low threshold of language proficiency has been achieved (in this case, one year of schooling), would be representative of the child's overall ability. This is in keeping with the findings of McVeigh, Wylie and Mulhern (2019) who found no significant difference between Irish and English scores on tasks measuring VSTM of 7 and 9 year-old children in Irish immersion education.

RQ2 To what extent can metalinguistic phonemic awareness and linguistic phonemic awareness be considered the same construct (i) within languages and (ii) across languages?

As expected, the relationship between Phoneme Deletion scores (measuring MPA) across languages is much stronger than the relationship between Phoneme Matching scores (measuring LPA) across languages: while there is a strong correlation between Phoneme Deletion scores in Irish and English ($r = .84$), there is a moderate correlation between Phoneme Matching scores in Irish and English ($r = .52$). This is in keeping with the finding pertaining to RQ1 which indicated that there was no significant difference between Irish and English Phoneme Deletion scores, but that there was a significant difference between Irish and English Phoneme Matching scores. This finding provides an additional piece of

evidence in support of Saiegh-Haddad's (2019) conceptualisation of PA, which posits that there is both a language-specific and language-universal component to PA.

There is a similar relationship between MPA and LPA within each language: in each case, there is a weak positive correlation between Phoneme Matching and Phoneme Deletion scores. This is consistent with the finding that MPA and LPA are separable constructs within a language. In terms of practical implications for education, this would suggest that each of these constructs should be considered separate components of literacy instruction and in literacy screeners. Together, these findings suggest that dual-language PA training should (i) include elements of both MPA – the ability to manipulate (segment, delete, isolate and blend phonemes) as well as LPA - the ability to identify the phonemes in a language - and (ii) that LPA should be trained in each language separately.

RQ3 Which phonemic contrasts are typically identified inaccurately in Irish-English bilinguals?

English: The GT and GS group differed somewhat in terms of the phonemic contrasts that posed a difficulty for them in English. The most striking contrast is in Grade 1 scores: the GS group had no low accuracy (<50%) items, while the GT group had four (matching pairs /a/-/a/ [*apple-actor*] and /ɹ/- /ɹ/ [*ring-wrist*]; mismatching pairs /a/- /ɑ/ [*apple-otter*] and /w/-/ɹ/ [*water-writing*]). The errors relating to /a/-/ɑ/ in English may occur in this group of Gaeltacht children because these two qualities occur as allophones of a single low /a/ phoneme in Irish.

In Grade 2 and 3, the GT and GS group achieved less than 50% accuracy on the mismatching vowels represented by the same grapheme (/a/-/eɪ/ [*actor-angel*] represented by <a>, and /ɑ/-/o:/ [*ostrich-open*] represented by <o>). The Grade 2 GT group had an additional low accuracy item /s/-/ʃ/ (*sugar-sunny*; both represented by <s>). This suggests an initial reliance on phonological representations in Grade 1, followed by a shift to reliance on orthographic representations from Grade 2 onwards, even on a purely verbal task. This is consistent with the findings of previous studies which indicate that exposure to orthographic representations changes the way in which children perform LPA tasks (Castles et al, 2011).

Irish. The GT and GS groups also differed slightly in terms of the phonemic contrasts that posed a difficulty for them in Irish. The Grade 1 GT group had three low accuracy items; two velarised-palatalised consonant contrasts (/bˠ/-/bʲ/ and /dˠ/-/dʲ/) and one long-short vowel contrast (/ɛ/-/e:/). In Grade 2 and 3, there were six low accuracy items; all four velarised-palatalised and the two long-short vowel contrasts. The GT Grade 1

participants had a higher (group-level) accuracy than Grade 2 participants on the velarised-palatalised consonant contrasts, but performed similarly to Grade 3 participants. Three of the velarised-palatalised consonants have a higher average (group-level) accuracy in Grade 3 than in Grade 2 (bˠ/-/bʲ/, /dˠ/-/dʲ/ and /cʲ/-/kˠ/), while one has lower average (group-level) accuracy in Grade 3 (/sˠ/ and /ʃʲ/).

This pattern indicates an initial awareness of the palatalised-velarised consonant contrasts in Grade 1 participants, which dips in Grade 2 and rises again in Grade 3 in GT participants (note though that this study is cross-sectional in nature, and this pattern would need to be investigated in a longitudinal study to provide more robust evidence). This appears to reflect a U-shaped learning curve which has previously been identified in phonological acquisition (e.g. Liu & Kager, 2017) and spelling acquisition (e.g. Juul & Elbro, 2004; Notenboom & Reitsma, 2017).

Indeed, non-linear development is ubiquitous within domains of human learning (Gershkoff-Stowe & Thelen, 2004). Siegler (2004) notes that this phenomenon occurs due to the adoption of a new processing approach which results in an overall improvement in performance, but also in poorer performance in a specific domain in which the new approach is inherently flawed. In this case, the dip in performance in one domain (phonemic awareness) can be argued not to represent a regression, but rather a by-product of the development of orthographic awareness.

This U-shaped curve was not present in the GS group. All of the GS groups achieved less than 50% accuracy on three of the velarised-palatalised consonant contrasts (bˠ/-/bʲ/, /dˠ/-/dʲ and /cʲ/-/kˠ/) and on the long-short vowel contrast (/ɛ/-/eː/). The Grade 1 and Grade 3 GS groups had an additional low accuracy item; the long-short vowel contrast /ʌ/-/oː/. In contrast to the GT group, the average (group-level) accuracy on all of these items was lower in Grade 3 than in Grade 2. It is also of note that the (/sˠ/-/ʃʲ/) contrast was not a low accuracy item in any of the GS groups.

It is likely that the ability to distinguish between the velarised-palatalised consonant contrasts is affected by multiple, inter-related factors. The first is the exposure to post-traditional forms of Irish which may not produce these contrasts consistently (see § 2.1.2); this would be a factor more relevant to GS participants than GT participants. The second is the opaque representation of these contrasts in Irish orthography, which can hinder the acquisition of novel phonemes (Escudero, 2014). The third factor is the approach to instruction; phonological awareness is viewed as a language-universal ability in the Primary Language Curriculum (National Council for Curriculum and Assessment, 2015) and the importance of language-specific awareness of the phonemic inventory is not

emphasised. As these contrasts are fundamental to understanding the orthographic rules, explicit instruction should be provided in the form of (i) phonemic awareness training which focuses on the velarised-palatalised contrasts and long-short vowel contrasts and (ii) training in relation to how these phonemic contrasts are represented in Irish orthography.

RQ4 Are phonemic awareness errors reflected in the spelling errors made in Irish and English?

There is evidence that the errors made on the Phoneme Matching task are reflected in the spelling errors made in Irish and English. The errors made by the GS and GT Grade 3 groups on the Phoneme Matching task were similar, and as such the data pertaining to the spelling task was analysed for both groups together. The item-level analysis of the Phoneme Matching task indicated that, in English, the low accuracy items were the vowel contrasts which are represented by the same vowel grapheme in English (/a/-/ei/ represented by <a>, /ɑ/-/o:/ represented by <o>). In Irish, the low accuracy items were the long-short vowel contrasts and palatalised-velarised consonant contrasts.

The most prevalent error on the Irish Spelling task was the omission of vowels letters which mark consonant quality, accounting for 26% of the total errors. In addition, long-short vowel errors accounted for 10% of the total errors. This indicates that over a third of the total spelling errors are accounted for by the low accuracy items on the Phoneme Matching task. However, it is not clear to what extent these are purely phonological errors, or whether they stem from orthographic errors (i.e. a simplification of spelling; discussed below).

The most prevalent error on the English Spelling task was the use of a phonologically-plausible alternative grapheme, accounting for 20% of the total errors. The most prevalent phonologically-implausible error was long-short vowel errors, accounting for 16% of the total spelling errors. This occurred in two spelling items *boat* and *rope*, which require a more complex spelling rule (a digraph or final-e). Again, these errors may results from a simplification of an orthographic rule, rather than a purely phonological error.

In his model of spelling development in English, Gentry (1982) makes a distinction between the *phonetic stage*, in which individual segments are represented though they are simplified (e.g. <saf> instead of <safe>) and the *transitional stage*, in which digraphs are used (and sometimes overused). Treiman (2000) argues that orthographic errors are often phonologically-primed, using the example that <r> is used more often to represent the phonological unit /ɑɹ/ than <b> is used to represent the phonological unit /bi/ due to the close relationship between /ɹ/ and the neighbouring vowels. The phoneme /ɹ/ - though a consonant - is vowel-like and in sequences such as [ɑɹ] there is little acoustic difference in

the vowel and following consonant, and no acoustic discontinuity. It is probable that there are multiple factors which contribute to errors on phonological tasks and spelling tasks, and that errors arise in the case of similar phonemes that *also* have either complex representation or ambiguous representations in the orthography.

There is also evidence that the issue cannot be reduced entirely to the simplification of spelling patterns, as the proportion and absolute value of consonant marker errors in Irish far exceeds those of phonemes in English which are represented by digraphs. There is ample evidence from previous studies that L2 phonemic awareness errors can result in spelling errors (Wang & Geva, 2003; Cronell, 1985; Zutell & Allen, 1988; Cook, 1997). However, similar errors occurred in both native and new speakers of Irish. This suggests that accurate production of phonemic contrasts (i.e. an implicit grasp of the phonological contrast) is not sufficient for the development of explicit phonemic awareness, as desirable for literacy acquisition. It appears likely that the lack of explicit phonemic awareness here reflects an awareness of the alphabetic letters (which do not differentiate these consonants), and if so, would suggest that participants were already familiar with the letters of the alphabet even in Grade 1.

Regardless of language profile, spelling requires both intact phonological representations as well as knowledge of the graphemes which correspond to them. The findings of this spelling error analysis indicate that there is much interdependence between orthographic and phonological representations, and that there may be multiple factors which contribute to spelling errors. They also reinforce the need for explicit training in phonemic awareness and subsequent explicit instruction in relation to the grapheme-phoneme rules, particularly in relation to long-short vowel contrasts in both languages and velarised-palatalised consonant contrasts in Irish.

RQ5a Is there evidence of orthographic effects or the use of orthographic strategies on responses to linguistic phonemic awareness and metalinguistic phonemic awareness tasks?

RQ5b If so, is there a relationship between the use of orthographic strategies and literacy attainment?

This question was investigated using the English Phoneme Matching and Phoneme Deletion tasks only. There was evidence of an asymmetric effect of orthographic opacity on the Phoneme Matching task (measuring LPA); there was a significant difference between median scores on orthographically-opaque and orthographically-transparent stimuli in the mismatching condition, but not in the matching condition. Though this was the case in every group - indicating a consistent effect - it was small (raw score of 3 items

correct compared to 4 items correct). Though these results are in need of replication in a larger study, they suggest that orthographic representations influence performance on PA tasks. This finding is in agreement with a previous study indicating the orthographic representations are automatically activated in PA tasks (Wang et al, 2018).

There was also evidence of the use of orthographic strategies on the Phoneme Deletion task (*rocks-box* stimuli), replicating findings from previous studies (Castles et al, 2003; Stuart, 1990). In addition, a higher proportion of Grade 3 participants (58%) used an orthographic strategy than Grade 2 participants (30%). Though this study was cross-sectional in nature, and therefore cannot indicate development in a definitive way, this does appear to be indicative of a switch from dependence on phonological strategies to the use of orthographic strategies. This is in keeping with Castles & Coltheart's (2004) proposal that experience with literacy instruction changes the way in which they perform PA tasks.

As in Stuart's (1990) study, those who used an orthographic strategy had higher literacy attainment scores in Grade 2 (Irish Word Reading) and Grade 3 (Irish and English Word Reading and Spelling) than those who used a phonological strategy and those who provided incorrect responses. However, this difference only reached significance for Grade 2 Word Reading attainment. This would suggest that an element of what PA tasks assess is the degree of alphabetisation (or the quality of orthographic representations) that a child has.

If PA is essentially an indirect measure of orthographic ability, its usefulness as a predictor would be limited. It has been suggested, though, that orthographic representations build on phonological representations (e.g. Fowler, 1991; Mann & Wimmer, 2002). This would appear to add to the evidence supporting a reciprocal relationship between phonemic awareness and literacy skills, found in longitudinal studies (Wagner, Torgesen & Rashotte, 1994; Burgess & Lonigan, 1998; Peterson et al, 2018).

RQ6a How well do scores on the predictor tasks predict word reading and spelling attainment in GS and GT groups in Irish and English?

The results of the present study indicate that the predictors are more effective at predicting Word Reading than Spelling, and more effective at predicting Irish literacy attainment than English literacy attainment. The Adjusted R^2 values indicate that the predictor variables accounted for 54% of the variance in Irish Word Reading (in Grade 2 and Grade 3), and 49% of the variance in English Word Reading (in Grade 3). They accounted for less variance in Spelling in each language, explaining 40% of the variance in Irish Spelling and 36% of the variance in English Spelling. It is difficult to compare these values across studies due to methodological differences, however they are broadly comparable to those

found in other dual-language studies which use similar predictor variables and statistical methods (e.g. Lindsey et al, 2003[62]; Swanson et al, 2008[63] investigating English-Spanish language pairs).

It is of note that the demographic variables (age, sex, home language and language of pre-school education) and school variable accounted for differing amounts of variance in Irish and English. For Irish, the demographic variables accounted for 9% of the variance in Grade 2 Irish Word Reading, but did not account for a significant amount of variance in Grade 3 Irish Word Reading and Spelling. In contrast, the school variable accounted for 6% of the variance in Grade 2 Irish , but 13 – 17% of the variance in Grade 3 Irish Word Reading and Spelling. For English Grade 3 Word Reading and Spelling – in which the participants had less than a year of literacy instruction – the pattern was more similar to that of the Grade 2 Irish Word Reading; the demographic variables accounted for 4-7% of variance, and the school variable accounting for 7% of the variance. This perhaps indicates the initial importance of the home and pre-school language environment at the initial stages of literacy instruction, and a shift towards the school environment as the locus of influence thereafter.

Another point of interest is the additional variance accounted for by the predictor variables in the alternative language. When entered in the last step in the regression analysis, the English language independent variables did not account for any additional variance in Irish Word Reading or Spelling; however, the Irish language variables accounted for an additional 5-7% of variance in English Word reading and Spelling. This is discussed further in relation to RQ6b below.

RQ6b What are the strongest predictors of word reading and spelling attainment in Irish and English in GT and GS groups?

The strength of predictors differed in Irish and English, which is typical in dual-language literacy environments (Pasquarella et al, 2015; Jared et al, 2011; Swanson et al, 2008; Veii & Everatt, 2005; Lindsey, Manis & Bailey, 2003; Gottardo & LaFrance, 2005). The constructs which were unique predictors in each language are discussed below.

Irish literacy attainment. Overall, Irish Phoneme Deletion was the most effective predictor of Irish literacy attainment. It was most effective at predicting Grade 2 Word

[62] In this study (Lindsey et al, 2003), 57% of the variance in Grade 2 English Word Identification was accounted for by the variables. Only the R^2 value is reported in this article; the R^2 value is higher than the Adjusted R^2 value which is the focus of this discussion).

[63] In this study (Swanson et al, 2008), 26% of the variance in Grade 3 English word reading and 67% of the variance in Grade 3 Spanish word reading was accounted for. Only the R^2 value is reported in this article; the R^2 value is higher than the Adjusted R^2 value which is the focus of this discussion).

Reading, followed by Grade 3 Word Reading and then Grade 3 Spelling. In contrast, Irish Phoneme Matching predicted Grade 3 Spelling, but was not a predictor of Word Reading. This finding is perhaps indicative of a higher demand on fundamentally phonological skills in spelling than in reading, given that Phoneme Matching depends on awareness of the phonemic inventory, whereas Phoneme Deletion has a larger metalinguistic component.

Irish RAN did not predict Grade 2 Irish Word Reading, but did predict Grade 3 Irish Word Reading and Spelling. This is consistent with previous research which suggest that PA is a more potent predictor in the earlier stages of literacy development, and RAN becomes more effective in later stages (Vaessen et al, 2010). In this study, RAN contributed to Word Reading and Spelling to a similar degree, which contrasts with previous studies which suggest that RAN contributes more to skills for which (whole-word) orthographic representations are necessary (e.g. recognition of high frequency words), while PA is a better predictor of skills for which grapheme-phoneme knowledge is necessary (e.g. pseudoword decoding: Wollf, 2014; Manis et al, 1999).

Irish Forward Word Span predicted Grade 2 Word Reading and Spelling, albeit to a lesser extent than Phoneme Deletion and RAN. This is in keeping with the findings of Ziegler and colleagues (2010) who found that a task measuring VSTM was a predictor in some languages, though its contribution to literacy attainment was relatively weak. However, it contrasts with the findings of many cross-linguistic studies which have found that verbal short-term memory does not predict literacy attainment (Parrila et al, 2004; Mann & Wimmer, 2002; Caravolas et al, 2012; Vaessen et al, 2010).

English literacy attainment. Only one English language predictor – Phoneme Deletion – was effective in predicting Grade 3 English Word Reading and Spelling. Of these, Phoneme Deletion was a much more effective predictor of Word Reading than of Spelling. This mirrors the pattern for Irish, in which Phoneme Deletion accounted for more variance in Word Reading than in Spelling. Though none of the other English predictors were effective in predicting literacy attainment, two Irish predictors were. Irish RAN predicted English Word Reading, while Irish Phoneme Matching predicted English Spelling.

It is not immediately obvious why Irish RAN should predict English Word Reading and English RAN should not. However, a correlationary analysis on the Grade 3 participants data (reported in § 8.1.4) suggests two major differences between Irish and English RAN. The first is that Irish RAN is moderately correlated with Irish and English Phoneme Deletion, while English RAN is only weakly correlated with Irish and English Phoneme

Deletion[64]. This suggests that the underpinning components of Irish RAN have more in common with those of Phoneme Deletion (the strongest predictor variable) than do those of English RAN. These underpinning components could be specific in nature (e.g. phonological, orthographic) or pertain to a general linguistic aptitude. The second difference is that Irish RAN is moderately correlated with Irish Productive Vocabulary, while English RAN is only weakly correlated with Irish Productive Vocabulary[65].

Given that Irish and English RAN share a similar (weak) relationship with Phoneme Matching (a fundamentally phonological skill), the component specific to Irish RAN is unlikely to be phonological in nature. In light of the fact that Irish RAN has a closer relationship to Irish Productive Vocabulary, it is more likely that the underlying components which Irish RAN shares with Phoneme Deletion pertains to a language-specific aptitude for binding (semantic, visual or orthographic) codes with phonological items (at the phoneme or word level) in Irish. (Note that part of what Phoneme Deletion appears to measure is the degree of alphabetisation, i.e. binding of orthographic-phonological codes).

It could be speculated that this visual-phonological binding system was initially trained in Irish (the language of schooling and initial literacy instruction for all participants, and the home language of the vast majority of GT participants), and that it is now used to support the development of literacy skills in English. If this is the case, there would perhaps be a stronger effect in GT participants than for GS participants, given the development of their initial linguistic (vocabulary) systems and orthographic (word reading) systems in Irish. A correlational analysis bears this out: the relationship between Irish RAN and Grade 3 English Word Reading is stronger than the relationship between English RAN and Grade 3 English Word Reading in both groups, however the magnitude of the difference is greater for GT participants[66]. It must be emphasised that this interpretation is purely speculative, but could be examined in a future study by investigating the component skills of RAN in dual-language learners.

---

[64] Irish RAN is moderately correlated with Irish Phoneme Deletion ($r = -.530$, $p < 0.01$) and English Phoneme Deletion ($r = -.455$, $p < 0.001$; note that the correlation is negative as lower RAN scores indicate better performance). English RAN is weakly correlated with Irish Phoneme Deletion ($r = -.322$, $p < 0.01$) and English Phoneme Deletion ($r = -.264$, $p < 0.01$).

[65] Irish RAN is moderately correlated with Irish Productive Vocabulary ($r = -.433$, $p < 0.01$). English RAN is weakly correlated with Irish Productive Vocabulary ($r = -.218$, $p < 0.05$)

[66] Irish RAN has a closer relationship than English RAN to Grade 3 English Word Reading in both the GS and GT groups. The magnitude of the difference is larger in the GT group than in the GS group. For the GS group, the correlation between English RAN and Grade 3 English Word Reading is moderate ($r = -.417$, $p < 0.01$) as is the correlation between Irish RAN and Grade 3 English Word Reading ($r = -.501$, $p < .05$). In the GT group, the correlation between English RAN and Grade 3 English Word Reading is weak ($r_s = -.281$, $p < .05$) and the correlation between Irish RAN and Grade 3 Irish Word Reading is moderate ($r_s = -.677$, $p < .01$).

The nature of the contribution of Irish Phoneme Matching to the prediction of Grade 3 English Spelling also warrants further investigation. A follow-up correlationary analysis provides an indication of which conditions of Irish Phoneme Matching correlate with English Word Reading. The analysis suggests that certain conditions in the Irish Phoneme Matching task have a weak positive correlation with English Word Reading, while others do not. Specifically, identifying (i) matching initial consonant pairs and (i) matching vowel sounds is significantly correlated with English reading ($p = .003$ for matching consonant-vowel units; $p = .01$ for matching consonant phoneme units; $p = .019$ for matching vowel units). In contrast, identifying mismatching consonants (including the velarised-palatalised consonant contrasts) and identifying mismatching vowels did not correlate with English reading ($p = .730$ for mismatching consonant-vowel units; $p = .925$ for mismatching consonant phoneme units; $p = .071$ for mismatching vowel units). As such it appears that it is the basic ability to identify two matching phonemes which contributes to English Word Reading, as opposed to the more advanced ability to distinguish between phonemic contrasts in Irish (which do not occur in English).

9.3 Implications

Overall, the finding that GT and GS children readily acquire English literacy skills which match their Irish literacy skills by Grade 3 (First Class) is a positive one within dual-language literacy education; it attests to the fact that Irish language literacy skills are acquired with no adverse effects on English language literacy skills. This finding is in keeping with those of Parsons and Lyddy (2016). The ability of participants to learn to acquire foundational literacy skills in two quite different orthographies in the early years of schooling is quite remarkable. However, within the Irish context, it is paramount that language-specific instruction is provided in relation to the phonemic structure of Irish and the spelling rules of Irish, in order to maintain progress in Irish literacy acquisition.

9.3.1 The nature of bilingual (Irish-English) phonemic awareness: implications for instruction

Though frequently presented as a unitary construct, the findings of this study suggest that PA is an umbrella term for a range of abilities, some of which are essentially phonological, and some of which are complex, multi-component skills for which the label "phonological" may not be entirely appropriate.

LPA (measured by Phoneme Matching in the present study) is fundamentally phonological; it involves the explicit awareness of – and ability to distinguish between – the phonemic contrasts of a given language. It was found to be a unique predictor of spelling in the present study, which demonstrates its predictive validity in relation to literacy attainment. It is

evident from the findings of this study that the ability to accurately produce the phonemes of a language is not necessarily sufficient in order to have *explicit* awareness of the phonemic structure of a language. In addition to the explicit awareness of the phonemic contrasts of the language, in order for LPA to contribute positively to literacy attainment, it is necessary to also have knowledge of the grapheme(s) that represent the phonemes of the language.

MPA in contrast is a complex, multi-component skill. It is likely to have both a more fundamentally phonological component (building on established phonological representations), as well as a component which is essentially orthographic (measuring acquisition of the alphabetic principle and/or the binding of phonological-orthographic representations). This is attested to by its moderate correlation with both Phoneme Matching (measuring LPA) and RAN (measuring binding of phonological-visual representations) in Irish.

This proposition, and the wider relationships among the predictors is illustrated in Figure 71.

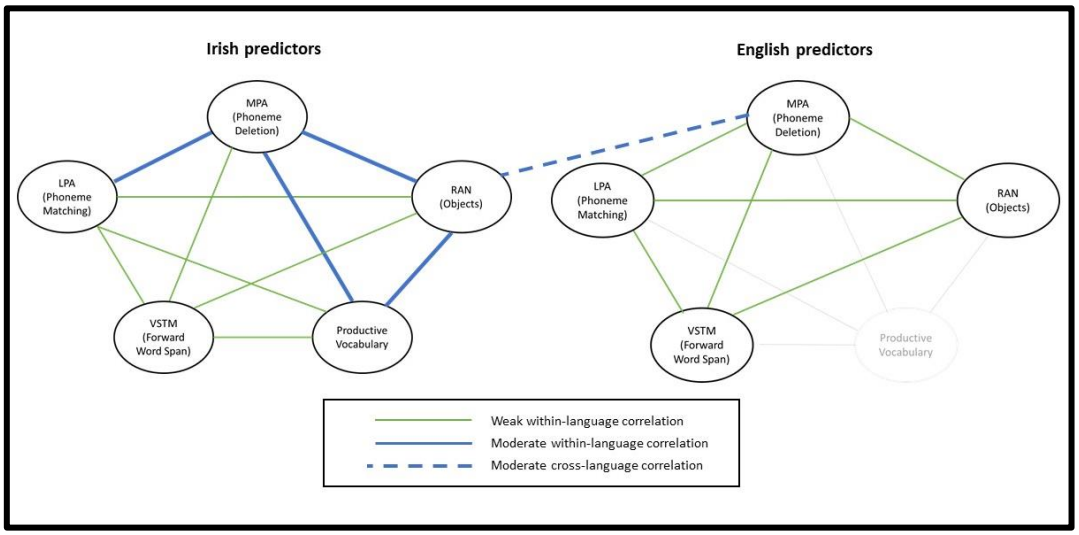

Figure 71 Schematic representation of the correlations between predictor variables in the study reported in this thesis. Green lines indicate a weak within-language correlation; blue lines indicate a moderate within-language correlation; broken blue line indicates a moderate cross-language correlation. Note that weak cross-language correlations are not illustrated in this diagram in order to maximise clarity.

Acquiring MPA appears to depend on exposure to literacy instruction and knowledge of the alphabetic principle. As pointed out by Liberman and colleagues (1974), the ability to segment and delete phonemes does not arise spontaneously. Phonemes are not discrete entities in speech production and perception, and there is often no discontinuity between segments. Early literacy training using an alphabet, which provides children with a concrete visual representation of a phoneme and is accompanied by repetition of discrete phonemes, provides a basis on which to perform such tasks. As literacy acquisition progresses, it

appears that successful readers often use a visual representation of a word in the mental lexicon to complete tasks which involve phoneme deletion.

The findings of the present study indicate that separate training should be provided in both MPA and LPA. Training LPA (green box on left-hand side of Figure 72) involves fostering the ability to distinguish between phonemic contrasts within a language, as they are crucial in order to understanding the spelling rules. Note that the opaque way in which the velarised-palatalised consonant contrasts are represented in the Irish orthography is likely to hinder the acquisition of these contrasts (see Escudero, 2014 for results pertaining to Dutch).

Ideally, awareness these contrasts should be trained before exposure to the orthography, which can be done with minimal pair training using pictoral prompts. Then, when the alphabet is introduced, monosyllabic words can be used to illustrate how these contrasts are represented in the orthography. This method could be modelled on syllabic phonics; a method which introduces short Consonant-Vowel syllables rather than isolated phonemes. This is a method used in Russian (Kerek & Niemi, 2012; Elkonin, 1988). a language with a similar phonemic structure to that of Irish As mentioned in § 2.3.2, an interactive game is being developed as part of the ABAIR project, according to these principles.

In contrast, training MPA (the purple box on the right-hand side of Figure 72) focuses on the ability to segment, isolate and delete phonemes in spoken words. This is typically done in tandem with teaching the alphabetic principle, and letters can be used as visual anchors which facilitate performance on these tasks. MPA is largely language-universal in alphabetic languages, and a common proficiency across Irish and English would be expected based on the findings of the present study.

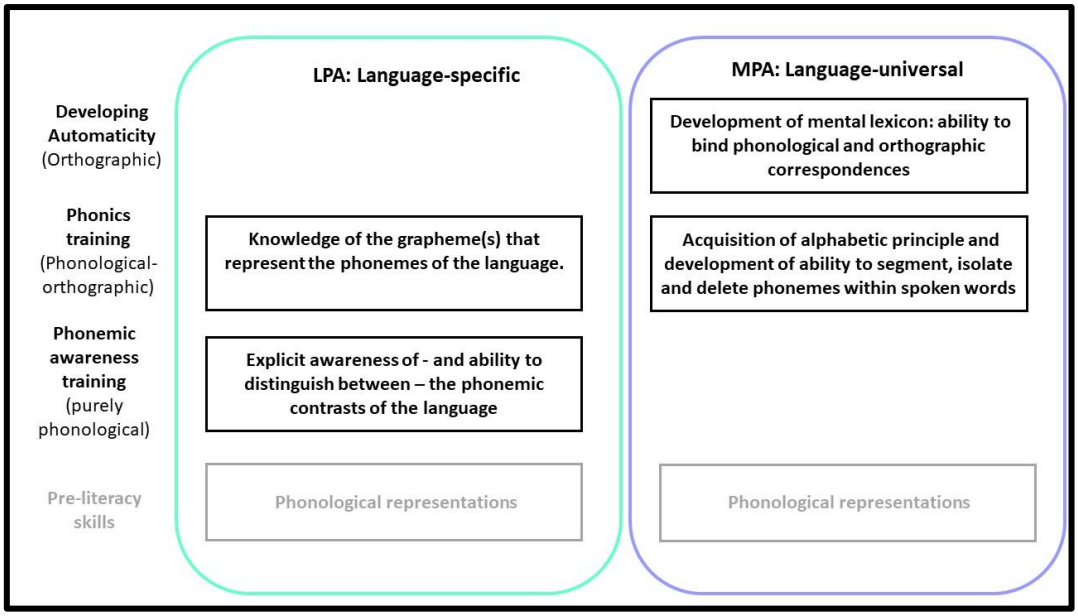

Figure 72 Stages in the development of LPA and MPA and related orthographic skills

9.3.2 The predictors of dual-language (Irish-English) literacy attainment: implications for assessment

Phoneme Deletion was the strongest predictor of literacy attainment in the present study in both Irish and English. If Phoneme Deletion is characterised essentially as a measure of alphabetisation or the binding of phonological-orthographic representations, it could appear that the use of such tasks in early literacy screening is redundant (as more direct measures such as letter knowledge and/or word reading could be used). However, in the context of identifying literacy difficulties, comparing LPA (Phoneme Matching) ability and MPA (Phoneme Deletion) ability could nonetheless be highly beneficial, and potentially reveal whether a person has a fundamental issue in phonological awareness or an issue with acquisition of the alphabetic principle or the binding of letter-sound correspondences.

Phoneme Matching predicted Spelling attainment, and is a useful task to include on a literacy screener as it allows for the identification of specific difficulties relating to the phonemic contrasts of a language. Phoneme Matching tasks can elucidate common errors or sources of difficulty which educators can then focus on at the class-level or with individuals; in the case of Irish-English bilinguals this appears to be the long-short vowel contrasts in both Irish and English, as well as the palatalised-velarised contrasts in Irish.

Irish RAN predicted Grade 3 Irish Word Reading and Spelling and Grade 3 English Word Reading. Though Irish RAN was a cross-language predictor, it should not be inferred that only Irish RAN should be included on literacy screeners or diagnostic assessments. The results of regression analyses (a *group-level* analysis) are not indicative of the performance of an *individual* child on as assessment. It is evident that RAN has a large language-specific

component and that assessing a native English speaker in Irish is unlikely to accurately reflect their overall ability, and vice versa. Instead, RAN should be administered in both languages. Due to its strong language-specific effects which are likely frequency-primed (Ivanova & Costa, 2008), RAN could be used as a measure of language dominance in other contexts.

Irish Forward Word Span (measuring VSTM) was a relatively weak predictor of Grade 2 Irish Word Reading and Grade 3 Irish Word Reading and Spelling, and was not a unique predictor of Grade 3 English Word Reading and Spelling. In addition, Irish Productive Vocabulary was not a unique predictor of literacy attainment in this study, though it should be noted that this was quite a short assessment of vocabulary which is unlikely to distinguish between levels in a fine-grained way. Dual-language vocabulary assessments established by Ciara O' Toole and colleagues (e.g. O' Toole, 2019) are much more comprehensive and are useful in the assessment of specific language difficulties.

The Cognitive Underlying Cognitive Processes theory states that L1 and L2 reading skills can be predicted by a common set of cognitive constructs (Chung et al, 2019), and that PA, RAN and short-term memory are not malleable: these findings provide clear evidence to the contrary, echoing previous research by Murphy and Travers (2012). It is necessary to examine literacy skills and subskills in each of a child's languages in order to draw meaningful and accurate conclusions on their development. This is crucial in this Irish context, where normed screening and diagnostic assessments are not yet available in Irish for children in GS and GT schools.

Establishing dual-language screeners and diagnostic tests with normative data for Gaeltacht pupils and for pupils in Gaelscoileanna should be an urgent priority. Given the difference in language background of these two groups, it is necessary to develop separate norms for each group. Even within these groups, there is wide variation with regard to the use of and exposure to each language. It should be noted that Virginia Mueller Gathercole and colleagues have developed standardised tests of receptive vocabulary for Welsh with norms which take into account the child's exposure to the language (Mueller Gathercole, Mon Thomas, & Hughes, 2008)

9.4 Contribution

The study reported in this thesis provides a number of theoretical and practical contributions, described below.

I. **Knowledge in relation to the construct validity of PA in dual-language learners**. The study reported in this thesis contributes to the current state of

knowledge in relation to the nature and validity of PA in dual-language learners. The contributions include the (i) confirmation that there are both language-specific and language-universal component to PA (ii) identification of phonemic contrasts typically inaccurately identified in Irish and English (iii) establishment of the predictive validity of LPA and MPA (iv) indication that phonemic awareness errors did appear to be reflected in the spelling errors made by participants (v) provision of additional evidence that support the findings of previous studies which have found orthographic influences on responses to PA tasks.

II. **Knowledge in relation to predictors of literacy attainment in dual-language learners.** This thesis also contributes to the current state of knowledge in relation to the predictors of literacy attainment in dual-language learners, and in Irish-English bilinguals specifically. This is an area which has not been previously investigated. The findings suggest that there are different patterns in Irish and English, and provides an indication of the relative strength of each predictor. In addition, the contribution of demographic variables and the influence of the school was examined; the findings suggest a stronger initial influence of demographic variables in the first year of literacy instruction, followed by a shift towards school as the primary source of influence thereafter.

III. **Tasks and related data which could support the development of a dual-language literacy screener.** As part of this study, a battery of tasks were developed in Irish and English to measure the phonological, cognitive and literacy-related variables in this study. Data was gathered from a sizeable number of participants which – if expanded – could be used to develop norm-referenced tasks to be used in a literacy screener. In addition, the study provided findings in relation to the efficacy of these tasks in Irish-English bilinguals, as well as the extent to which they can be considered language-specific. Though this study did not examine interventions, a recent study has highlighted the potential of phonological awareness intervention to improve attainment in DEIS schools in the English-medium context (O'Sullivan, 2019). O'Sullivan notes that these findings support the use of phonological awareness interventions as a preventative measure. Future research could examine the possibility of developing shared resources which could be adapted for Irish and English.

IV. **Implications for teaching and assessment practices.** The findings of this study provide implications for educational practice. Specifically, a number of implications – outlined in § 9.3 - were delineated in relation to literacy instruction and assessment in Irish-English bilinguals. Though these relate to the dual-

language education context in Ireland, some of the findings are applicable to other similar dual-language contexts.

9.5 Future work

A number of avenues for future work – delineated below - are identified based on the present study.

I. **Further analysis of data collected in the present study**: existing data could be used to examine gender-related differences in performance on the tasks as well as to further analyse the spelling errors made.

II. **Extension of present study:** additional data could be gathered to overcome the limitations of the present study by
    a. examining the longitudinal predictors of literacy attainment, investigating the test-retest reliability of measures, and including a higher number of Gaeltacht participants.
    b. Conducting a more in-depth analysis of phonemic awareness which includes a wider set of phonemic contrasts in different positions (medial and final), as well as more repetitions of each contrast.
    c. Developing, in collaboration with others, a dual-language literacy screener drawing on the findings of the present study.

III. **Additional avenues of future work:** Within the Irish context, additional research is necessary in relation to the early identification of learning differences in Gaeltacht schools and in Gaelscoileanna. The development and efficacy-testing of interventions for those with learning differences – including dyslexia – in these settings would also be a worthwhile area of future research. Internationally, further cross-linguistic research in relation to literacy attainment and development is necessary both in order to provide data to inform curricula in other countries as well as to refine universal theories of literacy acquisition.

Works Cited

Aguinis, H., Gottfredson, R. K., & Joo, H. (2013). Best-practice recommendations for defining, identifying, and handling outliers. *Organizational Research Methods*, *16*(2), 270-301.

Alin, A. (2010). Multicollinearity. *Wiley Interdisciplinary Reviews: Computational Statistics*, *2*(3), 370-374.

All-Island Research Observatory, 2018. Socio-Economic Profile of the seven Gaeltacht Areas in Ireland. Maynooth University Social Sciences Unit. Available at https://www.maynoothuniversity.ie/sites/default/files/assets/document/GaeltachtAreaProfileEnglish_Online_0.pdf (accessed September 2020)

Alloway, T. P., Gathercole, S. E., & Pickering, S. J. (2006). Verbal and visuospatial short-term and working memory in children: Are they separable?. *Child development*, *77*(6), 1698-1716.

An Gúm. 2003. Séideán Sí: Cúrsa Comhtháite Gaeilge [Séideán Sí: Comprehensive Irish language Course]. Dublin: Foras na Gaeilge

Antonijevic, S., Muckley, S. A., & Müller, N. (2020). The role of consistency in use of morphosyntactic forms in child-directed speech in the acquisition of Irish, a minority language undergoing rapid language change. *Journal of Child Language*, *47*(2), 267-288.

Arnell, K. M., Joanisse, M. F., Klein, R. M., Busseri, M. A., & Tannock, R. (2009). Decomposing the relation between Rapid Automatized Naming (RAN) and reading ability. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale*, *63*(3), 173.

Aro, M., & Wimmer, H. (2003). Learning to read: English in comparison to six more regular orthographies. *Applied psycholinguistics*, *24*(4), 621.

Au-Yeung, K., Hipfner-Boucher, K., Chen, X., Pasquarella, A., D'Angelo, N., & Hélène Deacon, S. (2015). Development of English and French language and literacy skills in EL1 and EL French immersion students in the early grades. *Reading Research Quarterly*, *50*(2), 233-254.

Baddeley, A. (2003). Working memory and language: An overview. *Journal of communication disorders*, *36*(3), 189-208.

Baddeley, A. D., & Hitch, G. J. (1974).Working memory. In G. A. Bower (Ed.), Recent advances in learning and motivation (Vol. 8, pp. 47–90). New York: Academic Press.

Baddeley, A., Gathercole, S., & Papagno, C. (1998). The phonological loop as a language learning device. *Psychological review*, *105*(1), 158.

Barac, R., Bialystok, E., Castro, D. C., & Sanchez, M. (2014). The cognitive development of young dual language learners: A critical review. *Early childhood research quarterly*, *29*(4), 699-714.

Barnes, E. *Dyslexia Assessment and Reading Interventions for Pupils in Irish- Medium Education:insights into current practice and considerations for improvement* [Unpublished M.Phil thesis, Trinity College Dublin].

Beins, B. C., & McCarthy, M. A. (2017). *Research methods and statistics*. Cambridge University Press.

Belfast Education and Library Board [Bord Oideachais agus Leabharlainne Bhéal Feirste]. (2011) *Fónaic na Gaeilge.* Belfast: BELB/An tÁisaonad.

Below, J. L., Skinner, C. H., Fearrington, J. Y., & Sorrell, C. A. (2010). Gender differences in early literacy: Analysis of kindergarten through fifth-grade dynamic indicators of basic early literacy skills probes. *School Psychology Review*, *39*(2), 240-257.

Ben-Dror, I., Frost, R., & Bentin, S. (1995). Orthographic representation and phonemic segmentation in skilled readers: A cross-language comparison. *Psychological Science*, *6*(3), 176-181.

Bennett, R., Ní Chiosáin, M., Padgett, J., & McGuire, G. (2018). An ultrasound study of Connemara Irish palatalization and velarization. *Journal of the International Phonetic Association*, *48*(3), 261-304.

Benton, T. (2015). An empirical assessment of Guttman's Lambda 4 reliability coefficient. In *Quantitative psychology research* (pp. 301-310). Springer, Cham.

Bialystok, E., Craik, F., & Luk, G. (2008). Cognitive control and lexical access in younger and older bilinguals. *Journal of Experimental Psychology: Learning, memory, and cognition*, *34*(4), 859.

Blachman, B. A. (1984). Relationship of rapid naming ability and language analysis skills to kindergarten and first-grade reading achievement. *Journal of Educational Psychology*, *76*(4), 610.

Blau, V., Reithler, J., van Atteveldt, N., Seitz, J., Gerretsen, P., Goebel, R., & Blomert, L. (2010). Deviant processing of letters and speech sounds as proximate cause of reading failure: a functional magnetic resonance imaging study of dyslexic children. *Brain*, *133*(3), 868-879.

Blau, V., van Atteveldt, N., Ekkebus, M., Goebel, R., & Blomert, L. (2009). Reduced neural integration of letters and speech sounds links phonological and reading deficits in adult dyslexia. *Current Biology*, *19*(6), 503-508.

Blomert, L. (2011). The neural signature of orthographic–phonological binding in successful and failing reading development. *Neuroimage*, *57*(3), 695-703.

Bonnin, J. E. (2013). New dimensions of linguistic inequality: an overview. *Language and Linguistics Compass*, *7*(9), 500-509.

Boonk, L., Gijselaers, H. J., Ritzen, H., & Brand-Gruwel, S. (2018). A review of the relationship between parental involvement indicators and academic achievement. *Educational Research Review*, *24*, 10-30.

Borsboom, D., Cramer, A. O., Kievit, R. A., Scholten, A. Z., & Franić, S. (2009). The end of construct validity. In *The Concept of Validity: Revisions, New Directions and Applications, Oct, 2008*. IAP Information Age Publishing.

Bowers, J. S., & Bowers, P. N. (2017). Beyond phonics: The case for teaching children the logic of the English spelling system. *Educational Psychologist*, *52*(2), 124-141.

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual review of psychology*, *53*(1), 371-399.

Branum-Martin, L., Tao, S., Garnaat, S., Bunta, F., & Francis, D. J. (2012). Meta-analysis of bilingual phonological awareness: Language, age, and psycholinguistic grain size. *Journal of Educational Psychology*, *104*(4), 932.

Breacadh. (2012) *Mar a Déarfá!* An Focal Scríofa don Chainteoir Dúchais Gaeilge. Gaillimh: Breacadh

Breusch, T. S., & Pagan, A. R. (1979). A simple test for heteroscedasticity and random coefficient variation. *Econometrica: Journal of the econometric society*, 1287-1294.

Bruck, M., & Genesee, F. (1995). Phonological awareness in young second language learners. *Journal of child Language*, *22*(2), 307-324.

Burgess, S. R., & Lonigan, C. J. (1998). Bidirectional relations of phonological sensitivity and prereading abilities: Evidence from a preschool sample. *Journal of experimental child psychology*, *70*(2), 117-141.

Butler, Y. G. (2013). Bilingualism/multilingualism and second-language acquisition. *The handbook of bilingualism and multilingualism*, 109-136.

Calvo, A., & Bialystok, E. (2014). Independent effects of bilingualism and socioeconomic status on language ability and executive functioning. *Cognition*, *130*(3), 278-288.

Camilli, G., Vargas, S., & Yurecko, M. (2003). Teaching children to read: The fragile link between science & federal education policy. *education policy analysis archives*, *11*, 15.

Caravolas, M., Lervåg, A., Defior, S., Seidlová Málková, G., & Hulme, C. (2013). Different patterns, but equivalent predictors, of growth in reading in consistent and inconsistent orthographies. *Psychological science*, *24*(8), 1398-1407.

Caravolas, M., Lervåg, A., Mousikou, P., Efrim, C., Litavský, M., Onochie-Quintanilla, E., ... & Seidlová-Málková, G. (2012). Common patterns of prediction of literacy development in different alphabetic orthographies. *Psychological science*, *23*(6), 678-686.

Caravolas, M., Volín, J., & Hulme, C. (2005). Phoneme awareness is a key component of alphabetic literacy skills in consistent and inconsistent orthographies: Evidence from Czech and English children. *Journal of experimental child psychology*, *92*(2), 107-139.

Castles, A., & Coltheart, M. (2004). Is there a causal link from phonological awareness to success in learning to read?. *Cognition*, *91*(1), 77-111.

Castles, A., Holmes, V. M., Neath, J., & Kinoshita, S. (2003). How does orthographic knowledge influence performance on phonological awareness tasks?. *The Quarterly Journal of Experimental Psychology Section A*, *56*(3), 445-467.

Castles, A., Wilson, K., & Coltheart, M. (2011). Early orthographic influences on phonemic awareness tasks: Evidence from a preschool training study. *Journal of Experimental Child Psychology*, *108*(1), 203-210.

Central Statistics Office. 2016. Profile 10 Education, Skills and the Irish Language. Dublin: Stationery Office. Available at http: https://www.cso.ie/en/releasesandpublications/ep/p-cp10esil/p10esil/ilg/ (accessed September 2020)

Chafouleas, S. M., VanAuken, T. L., & Dunham, K. (2001). Not all phonemes are created equal: The effects of linguistic manipulations on phonological awareness tasks. *Journal of Psychoeducational Assessment*, *19*(3), 216-226.

Chatterji, M. (2006). Reading achievement gaps, correlates, and moderators of early reading achievement: Evidence from the Early Childhood Longitudinal Study (ECLS) kindergarten to first grade sample. *Journal of educational psychology*, *98*(3), 489.

Chung, K. K., Liu, H., McBride, C., Wong, A. M. Y., & Lo, J. C. (2017). How socioeconomic status, executive functioning and verbal interactions contribute to early academic achievement in Chinese children. *Educational Psychology*, *37*(4), 402-420.

Chung, S. C., Chen, X., & Geva, E. (2019). Deconstructing and reconstructing cross-language transfer in bilingual reading development: An interactive framework. *Journal of Neurolinguistics*, *50*, 149-161.

Clarke, P., Hulme, C., & Snowling, M. (2005). Individual differences in RAN and reading: A response timing analysis. *Journal of Research in Reading*, *28*(2), 73-86.

Cohen, J., & Cohen, P. (1983). Applied multiple regression/correlation analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Erlbaum.

Comeau, L., Cormier, P., Grandmaison, E., & Lacroix, D. (1999). A longitudinal study of phonological processing skills in children learning to read in a second language. *Journal of Educational Psychology*, *91*(1), 29.

Comhchoiste na Gaeilge, na Gaeltachta agus na nOileán (2019). *Tuarascáil ar na dúshláin a bhaineann le hIonaid Cúraim Leanaí Lán-Ghaeilge a reáchtáil i gCeantair Ghaeltachta.* Tithe an Oireachtas: Baile Átha Cliath.

Cook, V. J. (1997). L2 users and English spelling. *Journal of Multilingual and Multicultural Development*, *18*(6), 474-488.

Cooper, A. (1994). An EPG Study of the Consonants of the Irish Dialect of Cois Fharraige. (M.Phil Thesis, Trinity College Dublin).

Cronbach, L. J., & Meehl, P. E. (1955). Construct validity in psychological tests. *Psychological bulletin*, *52*(4), 281.

Cronnell, B. (1985). Language influences in the English writing of third-and sixth-grade Mexican-American students. *The Journal of Educational Research*, *78*(3), 168-173.

Cummins, J. (1979). Linguistic interdependence and the educational development of bilingual children. *Review of educational research*, *49*(2), 222-251.

Cummins, J. (1981). The role of primary language development in promoting educational success for language minority students. *Schooling and language minority students. A theoretical framework.*

Cummins, J. (2005). Teaching for cross-language transfer in dual language education: Possibilities and pitfalls. In *TESOL Symposium on dual language education: Teaching and learning two languages in the EFL setting* (pp. 1-18). Estambul: Universidad BogaziciTurquía.

Cunningham, A. J., Witton, C., Talcott, J. B., Burgess, A. P., & Shapiro, L. R. (2015). Deconstructing phonological tasks: The contribution of stimulus and response type to the prediction of early decoding skills. *Cognition*, *143*, 178-186.

Daigle, D., Costerg, A., Plisson, A., Ruberto, N., & Varin, J. (2016). Spelling errors in French-speaking children with dyslexia: Phonology may not provide the best evidence. *Dyslexia*, *22*(2), 137-157.

Daniels, P. T., & Share, D. L. (2018). Writing system variation and its consequences for reading and dyslexia. *Scientific Studies of Reading*, *22*(1), 101-116.

Darcy, I., Mora, J. C., & Daidone, D. (2016). The role of inhibitory control in second language phonological processing. *Language Learning*, *66*(4), 741-773.

Darcy, I., Park, H., & Yang, C. L. (2015). Individual differences in L2 acquisition of English phonology: The relation between cognitive abilities and phonological processing. *Learning and Individual Differences*, *40*, 63-72.

Davies, R., Cuetos, F., & Glez-Seijas, R. M. (2007). Reading development and dyslexia in a transparent orthography: A survey of Spanish children. *Annals of dyslexia*, *57*(2), 179-198.

Davis, J. E. (1989). Construct validity in measurement: A pattern matching approach. *Evaluation and Program Planning*, *12*(1), 31-36.

Deci, E. L., & Ryan, R. M. (2008). Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian psychology/Psychologie canadienne*, *49*(3), 182.

De Houwer, A. (2011). Language input environments and language development in bilingual acquisition. *Applied Linguistics Review*, *2*, 221-240.

Delis, D. C., Jacobson, M., Bondi, M. W., Hamilton, J. M., & Salmon, D. P. (2003). The myth of testing construct validity using factor analysis or correlations with normal or mixed clinical populations: Lessons from memory assessment; Testing construct validity; DC Delis et al. *Journal of the International Neuropsychological Society: JINS*, *9*(6), 936.

DeLuca, V., Rothman, J., Bialystok, E., & Pliatsikas, C. (2019). Redefining bilingualism as a spectrum of experiences that differentially affects brain structure and function. *Proceedings of the National Academy of Sciences*, *116*(15), 7565-7574.

Denckla, M. B., & Rudel, R. (1974). Rapid "automatized" naming of pictured objects, colors, letters and numbers by normal children. *Cortex*, *10*(2), 186-202.

Denckla, M. B., & Rudel, R. G. (1976). Rapid 'automatized'naming (RAN): Dyslexia differentiated from other learning disabilities. *Neuropsychologia*, *14*(4), 471-479.

Department of Education and Skills (2005). *Deliverying Equality of Opportunity in Schools: An Action Plan for Educational Inclusion.* Retrieved from https://www.education.ie/en/Publications/Policy-Reports/deis_action_plan_on_educational_inclusion.pdf

Department of Education and Skills. (2011). *Lessons from Research on the Impact of DEIS.* Retrieved from https://www.education.ie/en/Schools-Colleges/Services/DEIS-Delivering-Equality-of-Opportunity-in-Schools-/Lessons-from-Research-on-the-Impact-of-DEIS.pdf.

Department of Education and Skills. (2016*). Polasaí don Oideachas Gaeltachta 2017-2022 [Policy on Gaeltacht education 2017-2022].* Retrieved from https://www.education.ie/ga/Foilseach%C3%A1in/Tuarasc%C3%A1lacha-Beartais/Polasai-don-Oideachas-Gaeltachta-2017-2022.pdf

Department of Education and Skills. (2018). *Schools Participating in the Gaeltacht School Recognition Scheme: Key Messages from Inspectorate Advisory Visits.* Retrieved from https://assets.gov.ie/25064/b860f427c86641259e681965745a395f.pdf

Duncan, G. J., & Magnuson, K. (2012). Socioeconomic status and cognitive functioning: moving from correlation to causation. *Wiley Interdisciplinary Reviews: Cognitive Science*, *3*(3), 377-386.

Duncan, L. G., & Seymour, P. H. (2000). Socio-economic differences in foundation-level literacy. *British Journal of Psychology*, *91*(2), 145-166.

Duncan, L. G., Seymour, P. H., & Hill, S. (1997). How important are rhyme and analogy in beginning reading?. *Cognition*, *63*(2), 171-208.

Dunne, C. M. & Hickey, T. M. (2017) *Roghanna agus Cleachtais Léitheoireachta an Aosa Óig.* Baile Átha Cliath: An Chomhairle um Oideachas Gaeltachta agus Gaelscolaíochta. Retrieved from https://www.cogg.ie/wp-content/uploads/cleachtais-agus-roghanna-leitheoireachta-an-aosa-oig.pdf

Edwards, I. G. H. (2008). Social factors and variation in production in L2 phonology. *Phonology and second language acquisition*, *36*, 251.

Ehri, L. C., Nunes, S. R., Willows, D. M., Schuster, B. V., Yaghoub-Zadeh, Z., & Shanahan, T. (2001). Phonemic awareness instruction helps children learn to read: Evidence from the National Reading Panel's meta-analysis. *Reading research quarterly*, *36*(3), 250-287.

Eivers, E., Gilleece, L., & Delaney, E. (2017). *Reading achievement in PIRLS 2016: Initial report for Ireland*. Dublin: Educational Research Centre.

Elkonin, D. B. (1963). The psychology of mastering the elements of reading. *Educational psychology in the USSR*, 165-179.

Elkonin, D. B. (1988). How to teach children to read. Advances in Psychology, 49, 387-426.

Escudero, P., Hayes-Harb, R., & Mitterer, H. (2008). Novel second-language words and asymmetric lexical access. *Journal of Phonetics*, *36*(2), 345-360.

Escudero, P., Simon, E., & Mulak, K. E. (2014). Learning words in a new language: Orthography doesn't always help. *Bilingualism: language and cognition*, *17*(2), 384-395.

Evans, M. A., Bell, M., Shaw, D., Moretti, S., & Page, J. (2006). Letter names, letter sounds and phonological awareness: An examination of kindergarten children across letters and of letters across children. *Reading and writing*, *19*(9), 959-989.

Ferguson, B., & Waxman, S. R. (2016). What the [beep]? Six-month-olds link novel communicative signals to meaning. *Cognition*, *146*, 185-189.

Figueredo, L. (2006). Using the known to chart the unknown: A review of first-language influence on the development of English-as-a-second-language spelling skill. *Reading and writing*, *19*(8), 873-905.

Flege, J. E. (1995). Second language speech learning: Theory, findings, and problems. *Speech perception and linguistic experience: Issues in cross-language research*, *92*, 233-277.

Folens (2011). *Reading Zone.* Dublin: Folens

Fowler, A. E. (1991). How early phonological development might set the stage for phoneme awareness. *Phonological processes in literacy: A tribute to Isabelle Y. Liberman*, *106*, 97-117.

Francisco, A. A., Groen, M. A., Jesse, A., & McQueen, J. M. (2017). Beyond the usual cognitive suspects: The importance of speechreading and audiovisual temporal sensitivity in reading ability. *Learning and Individual Differences*, *54*, 60-72.

Frost, R. (2012). Towards a universal model of reading. *Behavioral and Brain Sciences*, *35*(5), 263-279.

Frost, R., Armstrong, B. C., & Christiansen, M. H. (2019). Statistical learning research: A critical review and possible new directions. *Psychological Bulletin*, *145*(12), 1128.

Furnes, B., & Samuelsson, S. (2010). Predicting reading and spelling difficulties in transparent and opaque orthographies: A comparison between Scandinavian and US/Australian children. *Dyslexia*, *16*(2), 119-142.

Furnes, B., & Samuelsson, S. (2011). Phonological awareness and rapid automatized naming predicting early development in reading and spelling: Results from a cross-linguistic longitudinal study. *Learning and Individual differences*, *21*(1), 85-95.

Gaeloideachas (2020). *Statistics.* Available at: https://gaeloideachas.ie/i-am-a-researcher/statistics/ (accessed August 2020)

Galuschka, K., Ise, E., Krick, K., & Schulte-Körne, G. (2014). Effectiveness of treatment approaches for children and adolescents with reading disabilities: a meta-analysis of randomized controlled trials. *PloS one*, *9*(2), e89900.

Gathercole, V. C. M., Kennedy, I., & Thomas, E. M. (2016). Socioeconomic level and bilinguals' performance on language and cognitive measures. *Bilingualism: Language and Cognition*, *19*(5), 1057-1078.

Genesee, F. (1978). A longitudinal evaluation of an early immersion school program. *Canadian Journal of Education/Revue canadienne de l'éducation*, 31-50.

Genesee, F., & Jared, D. (2008). Literacy development in early French immersion programs. *Canadian Psychology/Psychologie canadienne*, *49*(2), 140.

Genesee, F., Geva, E., Dressler, C., & Kamil, M. (2006). Synthesis: Cross-linguistic relationships. *Developing literacy in second-language learners: Report of the National Literacy Panel on Language-Minority Children and Youth*, 153-174.

Gentry, J. R. (1982). An analysis of developmental spelling in" GNYS AT WRK". *The reading teacher*, *36*(2), 192-200.

Georgiou, G. K., Parrila, R., & Papadopoulos, T. C. (2008). Predictors of word decoding and reading fluency across languages varying in orthographic consistency. *Journal of Educational Psychology*, *100*(3), 566.

Gershkoff-Stowe, L., & Thelen, E. (2004). U-shaped changes in behavior: A dynamic systems perspective. *Journal of cognition and development*, *5*(1), 11-36.

Geva, E., & Ryan, E. B. (1993). Linguistic and cognitive correlates of academic skills in first and second languages. *Language learning*, *43*(1), 5-42.

Geva, E., Xi, Y., Massey-Garrison, A., & Mak, J. Y. (2019). Assessing Reading in Second Language Learners: Development, Validity, and Educational Considerations. In *Reading development and difficulties* (pp. 117-155). Springer, Cham.

Gilleece, L., Nelis, S.M., Fitzgerald, C. A & Cosgrove, J. (2020). *Reading, Mathematics and Science Achievement in DEIS schools: Evidence from PISA 2018.* Dublin: Educational Research Centre. Retrieved from https://www.erc.ie/wp-content/uploads/2020/11/ERC-DEIS-Report_Sept-2020_A4_Website.pdf

Glover, T. A., & Albers, C. A. (2007). Considerations for evaluating universal screening assessments. *Journal of School Psychology*, *45*(2), 117-135.

Gollan, T. H., Montoya, R. I., Cera, C., & Sandoval, T. C. (2008). More use almost always means a smaller frequency effect: Aging, bilingualism, and the weaker links hypothesis. *Journal of memory and language*, *58*(3), 787-814.

Gombert, J. E. (1992). *Metalinguistic development*. University of Chicago Press.

Goswami, U., & Bryant, P. (1990). Phonological skills and learning to read. Hillsdale, NJ: Lawrence Erlbaum.

Gottardo, A., & Lafrance, A. (2005). A longitudinal study of phonological processing skills and reading in bilingual children.

Government of Ireland. (2019). *National Childcare Scheme – ECCE Scheme*. Retrieved from https://www.gov.ie/en/publication/2459ee-early-childhood-care-and-education-programme-ecce/.

Guo, X., Lv, B., Zhou, H., Liu, C., Liu, J., Jiang, K., & Luo, L. (2018). Gender differences in how family income and parental education relate to reading achievement in China: The mediating role of parental expectation and parental involvement. *Frontiers in psychology*, *9*, 783.

Hachmann, W. M., Bogaerts, L., Szmalec, A., Woumans, E., Duyck, W., & Job, R. (2014). Short-term memory for order but not for item information is impaired in developmental dyslexia. *Annals of dyslexia*, *64*(2), 121-136.

Hambleton, R. K., & Patsula, L. (1999). Increasing the validity of adapted tests: Myths to be avoided and guidelines for improving test adaptation practices. *Journal of Applied Testing Technology, 1, 1, 30.*

Hambleton, R. K., Merenda, P. F., & Spielberger, C. D. (Eds.). (2004). *Adapting educational and psychological tests for cross-cultural assessment*. Psychology Press.

Hammer, C. S., Hoff, E., Uchikoshi, Y., Gillanders, C., Castro, D. C., & Sandilos, L. E. (2014). The language and literacy development of young dual language learners: A critical review. *Early childhood research quarterly*, *29*(4), 715-733.

Harm, M. W., & Seidenberg, M. S. (1999). Phonology, reading acquisition, and dyslexia: insights from connectionist models. *Psychological review*, *106*(3), 491.

Harris, J., Forde, P., Archer, P. Nic Fhearaile, S., O Gorman, M. (2006). *Irish in Primary Schools: Long-term national trends in achievement.* Dublin: Department of Education and Science.

Haynes, S. N., Richard, D., & Kubany, E. S. (1995). Content validity in psychological assessment: A functional approach to concepts and methods. *Psychological assessment*, *7*(3), 238.

He, J., & van de Vijver, F. (2012). Bias and equivalence in cross-cultural research. *Online readings in psychology and culture*, *2*(2), 2307-0919.

Hickey, T. (2005) Second language writing systems: Minority languages and reluctant readers. In V. Cook and B. Bassetti (eds) Second Language Writing Systems. Clevedon: Multilingual Matters

Hickey, T. M., & Stenson, N. (2016). One step forward and two steps back in teaching an endangered language? Revisiting L2 reading in Irish. *Language, Culture and Curriculum*, *29*(3), 302-318.

Hoff, E., Core, C., Place, S., Rumiche, R., Señor, M., & Parra, M. (2012). Dual language exposure and early bilingual development. *Journal of child language*, *39*(1), 1.

Høien, T., Lundberg, I., Stanovich, K. E., & Bjaalid, I. K. (1995). Components of phonological awareness. *Reading and writing*, *7*(2), 171-188.

Hulme, C., Snowling, M., Caravolas, M., & Carroll, J. (2005). Phonological skills are (probably) one cause of success in learning to read: A comment on Castles and Coltheart. *Scientific studies of reading*, *9*(4), 351-365.

Iosad, P & Ní Chiosáin, M 2016, 'Backness in Irish and Scottish Gaelic short vowels: Phonology and/or coarticulation', Paper presented at Fonologi i Skandinavien, Gothenburg, Sweden, 19/02/16 - 20/02/16.

Ivanova, I., & Costa, A. (2008). Does bilingualism hamper lexical access in speech production?. *Acta psychologica*, *127*(2), 277-288.

Jared, D., Cormier, P., Levy, B. A., & Wade-Woolley, L. (2011). Early predictors of biliteracy development in children in French immersion: A 4-year longitudinal study. *Journal of educational psychology*, *103*(1), 119.

Johnston, R. S., McGeown, S., & Watson, J. E. (2012). Long-term effects of synthetic versus analytic phonics teaching on the reading and spelling ability of 10 year old boys and girls. *Reading and Writing*, *25*(6), 1365-1384.

Juul, H., & Elbro, C. (2004). The links between grammar and spelling: A cognitive hurdle in deep orthographies?. *Reading and Writing*, *17*(9), 915-942.

Katz, L., & Frost, R. (1992). The reading process is different for different orthographies: The orthographic depth hypothesis. In *Advances in psychology* (Vol. 94, pp. 67-84). North-Holland.

Katz, R. B., Shankweiler, D., & Liberman, I. Y. (1981). Memory for item order and phonetic recoding in the beginning reader. *Journal of Experimental Child Psychology*, *32*(3), 474-484.

Kavanagh, L. (2013). *A Mixed methods investigation of parental involvement in Irish immersion primary education: Integrating multiple perspectives* [Doctoral dissertation, University College Dublin].

Kerek, E., & Niemi, P. (2009). Russian orthography and learning to read. *Reading in a Foreign Language*, *21*(1), 1-21.

Kerek, E., & Niemi, P. (2012). Grain-size units of phonological awareness among Russian first graders. *Written Language & Literacy*, *15*(1), 80-113.

Kibby, M. Y. (2009). There are multiple contributors to the verbal short-term memory deficit in children with developmental reading disabilities. *Child Neuropsychology*, *15*(5), 485-506.

Koda, K. (2008). Impacts of prior literacy experience on learning to read in a second language. *Learning to read across languages: Cross-linguistic relationships in first-and second-language literacy development*, 68-96.

Kroll, J. F., Michael, E., Tokowicz, N., & Dufour, R. (2002). The development of lexical fluency in a second language. *Second language research*, *18*(2), 137-171.

Kwak, S. K., & Kim, J. H. (2017). Statistical data preparation: management of missing values and outliers. *Korean journal of anesthesiology*, *70*(4), 407.

Lado, R. (1957). *Linguistics across cultures: Applied linguistics for language teachers*. Univ of Michigan Pr.

Landerl, K., Freudenthaler, H. H., Heene, M., De Jong, P. F., Desrochers, A., Manolitsis, G., ... & Georgiou, G. K. (2019). Phonological awareness and rapid automatized naming as longitudinal predictors of reading in five alphabetic orthographies with varying degrees of consistency. *Scientific Studies of Reading*, *23*(3), 220-234.

Landerl, K., Ramus, F., Moll, K., Lyytinen, H., Leppänen, P. H., Lohvansuu, K., ... & Kunze, S. (2013). Predictors of developmental dyslexia in European orthographies with varying complexity. *Journal of Child Psychology and Psychiatry*, *54*(6), 686-694.

Lane, D. (2003). *Online statistics education: A multimedia course of study* (pp. 1317-1320). Association for the Advancement of Computing in Education (AACE).

Levina, R.E. (1940). Deficiencies in Reading and Writing in Children.

Liberman, I. (1991). Phonology and beginning reading revisited. *Haskins Laboratories Status Report on Speech Research*, *105*(106), 1-8.

Liberman, I. Y. (1973). 1. Segmentation of the spoken word and reading acquisition. *Bulletin of the Orton Society*, *23*(1), 64-77.

Liberman, I. Y., and Shankweiler, D. 1979. Speech, the alphabet and teaching to read. In Theory and Practice of Early Reading, ed. L. B. Resnik and P. A. Weaver. Hillsdale, N.J.: Erlbaum

Liberman, I. Y., Shankweiler, D. P., & Liberman, A. M. (1989). The alphabetic principle and learning to read. In D. P. Shankweiler & I. Y. Liberman (Eds.), Phonology and reading disability: Solving the reading puzzle (pp. 1–33). Ann Arbor: University of Michigan Press.

Liberman, I. Y.; Shankweiler, D.; Fischer, F. W.; and Carter, B. 1974. Explicit syllable and phoneme segmentation in the young child. Journal of Experimental Child Psychology 18:201-12.

Lindsey, K. A., Manis, F. R., & Bailey, C. E. (2003). Prediction of first-grade reading in Spanish-speaking English-language learners. *Journal of educational psychology*, *95*(3), 482.

Liu, L., & Kager, R. (2017). Perception of tones by bilingual infants learning non-tone languages. *Bilingualism*, *20*(3), 561.

Logan, S., & Johnston, R. (2010). Investigating gender differences in reading. *Educational review*, *62*(2), 175-187.

López-Escribano, C., Ivanova, A., & Shtereva, K. (2018). Rapid Automatized Naming (RAN) and vocabulary are significant predictors of reading in consisting orthographies: a comparison of reading acquisition procedures in Bulgarian and Spanish.

Mackenzie, G. B., & Wonders, E. (2016). Rethinking intelligence quotient exclusion criteria practices in the study of attention deficit hyperactivity disorder. *Frontiers in psychology*, *7*, 794.

MacKinnon, D. P. (2011). Integrating mediators and moderators in research design. *Research on social work practice*, *21*(6), 675-681.

MacWhinney, B. (2005). Extending the competition model. *International Journal of Bilingualism*, *9*(1), 69-84.

Manis, F. R., Seidenberg, M. S., & Doi, L. M. (1999). See Dick RAN: Rapid naming and the longitudinal prediction of reading subskills in first and second graders. *Scientific Studies of reading*, *3*(2), 129-157.

Mann, V. A., & Liberman, I. Y. (1984). Phonological awareness and verbal short-term memory. *Journal of learning disabilities*, *17*(10), 592-599.

Mann, V., & Wimmer, H. (2002). Phoneme awareness and pathways into literacy: A comparison of German and American children. *Reading and writing*, *15*(7-8), 653-682.

McArthur, G., Sheehan, Y., Badcock, N. A., Francis, D. A., Wang, H. C., Kohnen, S., ... & Castles, A. (2018). Phonics training for English-speaking poor readers. *Cochrane Database of Systematic Reviews*, (11).

McBride-Chang, C. (1995). What is phonological awareness?. *Journal of Educational Psychology*, *87*(2), 179.

McCoy, S., Quail, A., & Smyth, E. (2012). Growing Up in Ireland–Influences on 9-Year-Olds' Learning: Home, School and Community. *Dublin: The Stationery Office*.

McIntosh, K., Reinke, W. M., Kelm, J. L., & Sadler, C. A. (2013). Gender differences in reading skill and problem behavior in elementary school. *Journal of Positive Behavior Interventions*, *15*(1), 51-60.

McVeigh, C., Wylie, J., & Mulhern, G. (2019). Verbal and visuospatial working memory in immersion-educated bilingual children. *International Journal of Bilingual Education and Bilingualism*, *22*(4), 505-517.

Meilleur, A., Foster, N. E., Coll, S. M., Brambati, S. M., & Hyde, K. L. (2020). Unisensory and multisensory temporal processing in autism and dyslexia: A systematic review and meta-analysis. *Neuroscience & Biobehavioral Reviews*.

Meir, N., & Armon-Lotem, S. (2017). Independent and combined effects of socioeconomic status (SES) and bilingualism on children's vocabulary and verbal short-term memory. *Frontiers in psychology*, *8*, 1442.

Melby-Lervåg, M., & Hulme, C. (2010). Serial and free recall in children can be improved by training: Evidence for the importance of phonological and semantic representations in immediate memory tasks. *Psychological science*, *21*(11), 1694-1700.

Melby-Lervåg, M., & Lervåg, A. (2011). Cross-linguistic transfer of oral language, decoding, phonological awareness and reading comprehension: A meta-analysis of the correlational evidence. *Journal of Research in Reading*, *34*(1), 114-135.

Melby-Lervåg, M., & Lervåg, A. (2014). Reading comprehension and its underlying components in second-language learners: A meta-analysis of studies comparing first-and second-language learners. *Psychological bulletin*, *140*(2), 409.

Melby-Lervåg, M., Lyster, S. A. H., & Hulme, C. (2012). Phonological skills and their role in learning to read: a meta-analytic review. *Psychological bulletin*, *138*(2), 322.

Messick, S. (1989). Validity. In R. L. Linn (Ed.), Educational measurement (3rd ed., pp. 13-103). New York: Macmillan.

Messick, S. (1995). Validity of psychological assessment: Validation of inferences from persons' responses and performances as scientific inquiry into score meaning. *American psychologist*, *50*(9), 741.

Moll, K., Ramus, F., Bartling, J., Bruder, J., Kunze, S., Neuhoff, N., ... & Tóth, D. (2014). Cognitive mechanisms underlying reading and spelling development in five European orthographies. *Learning and Instruction*, *29*, 65-77.

Morais, J., Alegría, J., & Content, A. (1987). The relationships between segmental analysis and alphabetic literacy: An interactive view. *Cahiers de psychologie cognitive*, *7*(5), 415-438.

Moyer, A. (2017). Autonomy in second language phonology: Choice vs. limits 1. *Language Teaching*, *50*(3), 395-411.

Muckley, S. A. (2015). *Language assessment of native Irish speaking children: towards developing diagnostic testing for speech and language therapy practice*. [Doctoral thesis, National University of Ireland, Galway].

Mueller Gathercole, V. C., Mon Thomas, E., & Hughes, E. (2008). Designing a normed receptive vocabulary test for bilingual populations: A model from Welsh. *International Journal of Bilingual Education and Bilingualism*, *11*(6), 678-720.

Mukaka, M. M. (2012). A guide to appropriate use of correlation coefficient in medical research. *Malawi medical journal*, *24*(3), 69-71.

Muñiz, J., Elosua, P., Hambleton, R. K., & International Test Commission. (2013). International Test Commission Guidelines for test translation and adaptation. *Psicothema*, *25*(2), 151.

Murphy, D., & Travers, J. (2012). Including young bilingual learners in the assessment process: A study of appropriate early literacy assessment utilising both languages of children in a Gaelscoil. Special and inclusive education: A research perspective, 167-185.

National Council for Curriculum and Assessment (NCCA) (2015) Primary Language Curriculum. Curriculum Online: available at http://www.curriculumonline.ie/Primary/Curriculum-Areas/Language-New-Junior- infants-2nd-class (acccessed April 2020)

National Council for Curriculum and Assessment (2019) Curaclam teanga na bunscoile: ábhar tacaíochta do mhúinteoirí: available at https://www.curriculumonline.ie/getmedia/c81ff35c-04d4-4b61-8c1e-e2ce28629577/PLC-Support-Materials_All-Strands-GAE-Final.pdf?ext=.pdf (accessed June 2020)

National Council for Curriculum and Assessment, 2020. Teaching for transfer of skills across languages: available at https://curriculumonline.ie/getmedia/ecc16cdb-fdd2-4e80-a31b-d1c8b0a2f741/OLRW_TransferOfSkills.pdf?ext=.pdf (accessed October 2020)

Ní Bhaoill, M. (2004) Tús na Léitheoireachta Foirmiúla Gaeilge agus Béarla i Scoileanna lán-Ghaeilge. Unpublished Thesis, St. Patricks's College

Ní Chasaide, A. (1979). Acoustic Study of Laterals in Donegal Irish and Hiberno-English. (Masters Thesis, University of Bangor).

Ní Chasaide, A. and Fealy, G. (1991). Articulatory and acoustic measurements of coarticulation in Irish (Gaelic) stops. *Proceedings of the 12th International Congress of Phonetic Sciences*, Aix-en-Provence, Vol. 4, 30-33.

Ní Chasaide, A. & Fritzpatrick, L. (1995). Assimilation of Irish palatalized and velarized stops. In *Proceedings of the XIIIth International Congress of Phonetic Sciences* (Vol. 1, pp. 334-337).

Ní Chasaide, A. (1999). Irish. In Handbook of the International Phonetic Association, pp. 111– 116. Cambridge: Cambridge University Press.

Ní Chasaide, A., Chiaráin, N. N., Berthelsen, H., Wendler, C., Murphy, A., Barnes, E., & Gobl, C. (2019). Leveraging Phonetic and Speech Research for Irish Language Revitalisation and Maintenance. In *ICPhS the 19th International Congress of Phonetic Sciences, Melbourne, Australia*.

Ní Chiaráin, N & Ní Chasaide, A. (2019). An iCALL approach to morphophonemic training for Irish using speech technology. *CALL and complexity*, 314.

Ní Chiaruain, M. (2009) An Examination of How Children with Dyslexia Experience Reading in Two Languages in a Gaelscoil [Unpublished thesis, St. Patrick's College, Dublin City University].

Ní Chiosain, M. & Padgett, J. (2012). An acoustic and perceptual study of Connemara Irish palatalization. *Journal of the international phonetic association*, *42*(2), 171-191.

Ní Chlochasaigh, K., Ó Duibhir, P. & Shiel, G. (2018). Dearcthaí agus Cleachtais Ghairmiúla maidir le Tionchar an Tumoideachais ar Dhaltaí i nGaelscoileanna atá lonnaithe i gCeantair faoi Mhíbhuntáiste: Deiseanna agus Dúshláin: Teacher Attitudes and Professional Practices in relation to the Impact of Immersion Education on Pupils in Irish-medium Schools that are located in Areas of Social Disadvantage: Opportunities and Challenges. *TEANGA, the Journal of the Irish Association for Applied Linguistics*, *25*, 74-98.

Ní Chuaig, N. (2016). *Iniúchadh ar chleachtais litearthachta i gcóras bunscolaíochta Chatagóir A na Gaeltachta: Cur chuige praiticiúil d'fhorbairt na scríbhneoireachta* [Doctoral thesis, Dublin City University].

Ní Mhathúna, J (2018). *An investigation into the teaching and learning of writing in English with First Class students in an early-immersion Gaelscoil setting.* [Masters thesis, St Patrick's College, Dublin City University].

Nic Aindriú, S., Ó Duibhir, P., & Travers, J. (2020). The prevalence and types of special educational needs in Irish immersion primary schools in the Republic of Ireland. *European Journal of Special Needs Education*, 1-17.

Nic Aindriú, S., Duibhir, P. Ó., & Travers, J. (2021). A Survey of Assessment and Additional Teaching Support in Irish Immersion Education. *Languages*, *6*(2), 62.

Noble, K. G., McCandliss, B. D., & Farah, M. J. (2007). Socioeconomic gradients predict individual differences in neurocognitive abilities. *Developmental science*, *10*(4), 464-480.

Norton, E. S., & Wolf, M. (2012). Rapid automatized naming (RAN) and reading fluency: Implications for understanding and treatment of reading disabilities. *Annual review of psychology*, *63*, 427-452.

Notenboom, A., & Reitsma, P. (2007). Spelling Dutch doublets: Children's learning of a phonological and morphological spelling rule. *Scientific Studies of Reading*, *11*(2), 133-150.

Ó Béarra, F. (2007). Late Modern Irish and the Dynamics of Language Change and Language Death. *The Celtic Languages in Contact*, 260.

Ó Duibhir, P. (2009). *The spoken Irish of sixth-class pupils in Irish immersion schools*. (Doctoral thesis). Trinity College Dublin.

Ó Duibhir, P. (2018). *Immersion education: Lessons from a minority language context*. Multilingual Matters.

Ó Giollagáin, C., Mac Donnacha, S., Ní Chualáin, F., Ní Shéaghdha, A. and O'Brien, M. (2007) Staidéar Cuimsitheach Teangeolaíoch ar Úsáid na Gaeilge sa Ghaeltacht: Tuarascáil Chríochnaitheach. Dublin: Government Stationery Office.

Ó hIfearnáin, T., & Ó Murchadha, N. (2011). The perception of Standard Irish as a prestige target variety. *Standard languages and language standards in a changing Europe* (2011), pp. 97–104.

Oliver, A., Johnson, M. H., Karmiloff-Smith, A., & Pennington, B. (2000). Deviations in the emergence of representations: A neuroconstructivist framework for analysing developmental disorders. *Developmental Science*, *3*(1), 1-23.

Ó Murchadha, N. P., Hornsby, M., Smith-Christmas, C., & Moriarty, M. (2018). New speakers, familiar concepts?. In *New Speakers of Minority Languages* (pp. 1-22). Palgrave Macmillan, London.

Ó Murchú, S. (1998). An Teanga Bheo: Gaeilge Chonamara. Baile Átha Cliath: Institiúd Teangeolaíochta Éireann

Osburn, H. G. (2000). Coefficient alpha and related internal consistency reliability coefficients. *Psychological Methods, 5*(3), 343–355. https://doi.org/10.1037/1082-989X.5.3.343

O'Toole, C., Ní Shíthigh, D., Molamphy, A., & Walsh, E. (2019). Findings from the first phase of developing a receptive vocabulary test for the Irish language. *International Journal of Bilingualism*, 1367006919848142.

Pae, H. K., Sevcik, R. A., & Morris, R. D. (2010). Cross-language correlates in phonological awareness and naming speed: evidence from deep and shallow orthographies. *Journal of Research in Reading*, *33*(4), 374-391.

Parilla, R., Kirby, J. R., & McQuarrie, L. (2004). Articulation rate, naming speed, verbal short-term memory and phonological awareness: Longitudinal predictors of early reading development. Scientific Studies of Reading, 8, 3–26.

Paris, S. G. (2005). Reinterpreting the development of reading skills. *Reading research quarterly*, *40*(2), 184-202.

Parsons, C. E., & Lyddy, F. (2009). Early reading strategies in Irish and English: Evidence from error types. *Reading in a Foreign Language*, *21*(1), 22-36.

Parsons, C. E., & Lyddy, F. (2016). A longitudinal study of early reading development in two languages: comparing literacy outcomes in Irish immersion, English medium and Gaeltacht schools. *International Journal of Bilingual Education and Bilingualism*, *19*(5), 511-529.

Pasquarella, A., Chen, X., Gottardo, A., & Geva, E. (2015). Cross-language transfer of word reading accuracy and word reading fluency in Spanish-English and Chinese-English bilinguals: Script-universal and script-specific processes. *Journal of Educational Psychology*, *107*(1), 96.

Patel, T. K., Snowling, M. J., & de Jong, P. F. (2004). A cross-linguistic comparison of children learning to read in English and Dutch. *Journal of Educational Psychology*, *96*(4), 785.

Perfetti, C. A., Beck, I., Bell, L. C., & Hughes, C. (1987). Phonemic knowledge and learning to read are reciprocal: A longitudinal study of first grade children. *Merrill-Palmer Quarterly (1982-)*, 283-319.

Peterson, R. L., Arnett, A. B., Pennington, B. F., Byrne, B., Samuelsson, S., & Olson, R. K. (2018). Literacy acquisition influences children's rapid automatized naming. *Developmental science*, *21*(3), e12589.

Péterváry, T., Ó Curnáin, B., Ó Giollagáin, C. and Sheahan, J. (2014). *Iniúchadh ar an gcumas dátheangach: An sealbhú teanga i measc ghlúin óg na Gaeltachta*. Dublin: An Chomhairle Um Oideachas Gaeltachta agus Gaelscolaíochta.

Petrocelli, J. V. (2003). Hierarchical multiple regression in counseling research: Common problems and possible remedies. *Measurement and evaluation in counseling and development*, *36*(1), 9-22.

Place, S., & Hoff, E. (2011). Properties of dual language exposure that influence 2-year-olds' bilingual proficiency. *Child development*, *82*(6), 1834-1849.

Protopapas, A., Fakou, A., Drakopoulou, S., Skaloumbakas, C., & Mouzaki, A. (2013). What do spelling errors tell us? Classification and analysis of errors made by Greek schoolchildren with and without dyslexia. *Reading and Writing*, *26*(5), 615-646.

Quinn, M. (2020). An Acoustic Study of the Vowels of Connemara Irish. (M.Phil Thesis, Trinity College Dublin).

Ramus, F., & Szenkovits, G. (2008). What phonological deficit?. *Quarterly journal of experimental psychology*, *61*(1), 129-141.

Rose, D. H., & Meyer, A. (2006). *A practical reader in universal design for learning*. Harvard Education Press. 8 Story Street First Floor, Cambridge, MA 02138.

Ross, K. N. (1978). *Sample design for educational survey research*. Oxford: Pergamon Press.

Saiegh-Haddad, E. (2007). Epilinguistic and metalinguistic phonological awareness may be subject to different constraints: Evidence from Hebrew. *First Language*, *27*(4), 385-405.

Saiegh-Haddad, E., & Geva, E. (2008). Morphological awareness, phonological awareness, and reading in English–Arabic bilingual children. *Reading and writing*, *21*(5), 481-504.

Saiegh-Haddad, E. (2019). What is phonological awareness in L2?. *Journal of Neurolinguistics*, *50*, 17-27.

Saito, K., Tierney, A., & Sun, H. (2019). Explicit and implicit aptitude effects on second language speech learning: Scrutinizing segmental, prosodic and temporal sensitivity and performance via behavioral and neurophysiological measures. *Bilingualism: Language and Cognition*.

Sandoval, T. C., Gollan, T. H., Ferreira, V. S., & Salmon, D. P. (2010). What causes the bilingual disadvantage in verbal fluency? The dual-task analogy. *Bilingualism*, *13*(2), 231.

Savill, N., Ellis, A. W., & Jefferies, E. (2017). Newly-acquired words are more phonologically robust in verbal short-term memory when they have associated semantic representations. *Neuropsychologia*, *98*, 85-97.

Schatschneider, C., Francis, D. J., Foorman, B. R., Fletcher, J. M., & Mehta, P. (1999). The dimensionality of phonological awareness: an application of item response theory. *Journal of Educational Psychology*, *91*(3), 439.

Schober, P., Boer, C., & Schwarte, L. A. (2018). Correlation coefficients: appropriate use and interpretation. *Anesthesia & Analgesia*, *126*(5), 1763-1768.

Seidenberg, M. S., & McClelland, J. L. (1989). A distributed, developmental model of word recognition and naming. *Psychological review*, *96*(4), 523.

Serrano, F., & Defior, S. (2008). Dyslexia speed problems in a transparent orthography. *Annals of dyslexia*, *58*(1), 81.

Setia, M. S. (2016). Methodology series module 3: Cross-sectional studies. *Indian journal of dermatology*, *61*(3), 261.

Seymour, P. H., Aro, M., Erskine, J. M., & COST, A. A8 network.(2003). *Foundation literacy acquisition in European orthographies. British Journal of Psychology*, *94*, 143-174.

Shapiro, S. S. & Wilk, M. B. (1965) An analysis of variance test for normality (complete samples). Biometrika 53 (3/4), 591 – 611.

Shaposhnikov, I.N. (1925). How to teach reading. *Novai Derevnia*.

Share, D. L. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition*, *55*(2), 151-218.

Share, D. L. (2008). On the Anglocentricities of current reading research and practice: The perils of overreliance on an" outlier" orthography. *Psychological bulletin*, *134*(4), 584.

Siegler, R. S. (2004). U-shaped interest in u-shaped development-and what it means. *Journal of Cognition and Development*, *5*(1), 1-10.

Sireci, S. G. (1998). The construct of content validity. *Social indicators research*, *45*(1-3), 83-117.

Sireci, S. G. (2007). On validity theory and test validation. *Educational Researcher*, *36*(8), 477-481.

Snesareva, M. (2017). Palatalisation in Dublin Irish, or how to speak Irish with a Dublin accent. *Studia Celtica Posnaniensia*, *2*(1), 63-80.

Snowling, M. (1998). Dyslexia as a Phonological Deficit: Evidence and Implications. Child Psychology & Psychiatry Review Volume 3, No. 1, 4 – 11.

Sprent, P., & Smeeton, N. C. (2016). *Applied nonparametric statistical methods*. CRC press.

Stahl, S. A., & Murray, B. A. (1994). Defining phonological awareness and its relationship to early reading. *Journal of educational Psychology*, *86*(2), 221.

Stenson, N. and Hickey, T. M. (2014) In defense of decoding. Journal of Celtic Language Learning, 18, 11-40

Stenson, N. and Hickey, T.M. (2016) When regular is not easy: Cracking the code of Irish orthography. Writing Systems Research , 8 (2):187-217

Stenson, N., & Hickey, T. (2018) *Understanding Irish Spelling*. Dublin: An Chomhairle Um Oideachas Gaeltacht agus Gaelscolaíochta

Stephens, C. (2013). *Executive function development: A comparison of monolingual and bilingual children in Ireland* (Doctoral thesis, Queen's University Belfast).

Stevenson, R. A., Wilson, M. M., Powers, A. R., & Wallace, M. T. (2013). The effects of visual training on multisensory temporal processing. *Experimental brain research*, *225*(4), 479-489.

Strauss, M. E., & Smith, G. T. (2009). Construct validity: Advances in theory and methodology. *Annual review of clinical psychology*, *5*, 1-25.

Stuart, M. (1990). Processing strategies in a phoneme deletion task. *The Quarterly Journal of Experimental Psychology*, *42*(2), 305-327.

Swanson, H. L., Rosston, K., Gerber, M., & Solari, E. (2008). Influence of oral language and phonological awareness on children's bilingual reading. *Journal of School Psychology*, *46*(4), 413-429.

Szenkovits, G., & Ramus, F. (2005). Exploring dyslexics' phonological deficit I: lexical vs sub-lexical and input vs output processes. *Dyslexia*, *11*(4), 253-268.

Ten Berge, J. M., & Sočan, G. (2004). The greatest lower bound to the reliability of a test and the hypothesis of unidimensionality. *Psychometrika*, *69*(4), 613-625.

The Council for the Curriculum, Examinations and Assessment [CCEA], (2012). *Cód na Gaeilge.* Belfast: CCEA

The Gaeltacht Act 2012 si 24 (Ire.) Dublin: Stationery Office

The Gaeltacht Areas Orders 1956 si 245 (Ire). Dublin: Stationery Office.

The Gaeltacht Areas Orders 1967 si 200 (Ire). Dublin: Stationery Office.

The Gaeltacht Areas Orders 1974 si 192 (Ire). Dublin: Stationery Office.

The Gaeltacht Areas Orders 1982 si 350 (Ire). Dublin: Stationery Office.

Thompson, P. A., Hulme, C., Nash, H. M., Gooch, D., Hayiou-Thomas, E., & Snowling, M. J. (2015). Developmental dyslexia: predicting individual risk. *Journal of Child Psychology and Psychiatry*, *56*(9), 976-987.

Thordardottir, E. (2011). The relationship between bilingual exposure and vocabulary development. *International Journal of Bilingualism*, *15*(4), 426-445.

Thorn, A. S., & Gathercole, S. E. (1999). Language-specific knowledge and short-term memory in bilingual and non-bilingual children. *The Quarterly Journal of Experimental Psychology: Section A*, *52*(2), 303-324.

Torgerson, C., Brooks, G., & Hall, J. (2006). *A systematic review of the research literature on the use of phonics in the teaching of reading and spelling*. Nottingham: DfES Publications.

Torgesen, J. K., Rashotte, C. A., & Wagner, R. K. (1999). *TOWRE: Test of word reading efficiency*. Toronto, Ontario: Psychological Corporation.

Torgesen, J., & Goldman, T. (1977). Verbal rehearsal and short-term memory in reading-disabled children. *Child Development*, 56-60.

Treiman, R., Broderick, V., Tincoff, R., & Rodriguez, K. (1998). Children's phonological awareness: Confusions between phonemes that differ only in voicing. *Journal of Experimental Child Psychology*, *68*(1), 3-21.

Turnbull, M., Hart, D., & Lapkin, S. (2003). Grade 6 French immersion students' performance on large-scale reading, writing, and mathematics tests: Building explanations. *Alberta Journal of Educational Research*, *49*(1).

Turnbull, M., Lapkin, S., & Hart, D. (2001). Grade 3 immersion students' performance in literacy and mathematics: Province-wide results from Ontario (1998-99). *Canadian modern language review*, *58*(1), 9-26.

Unsworth, S., Brouwer, S., de Bree, E., & Verhagen, J. (2019). Predicting bilingual preschoolers' patterns of language development: Degree of non-native input matters. *Applied Psycholinguistics*, *40*(5), 1189-1219.

Vaessen, A., Bertrand, D., Tóth, D., Csépe, V., Faísca, L., Reis, A., & Blomert, L. (2010). Cognitive development of fluent word reading does not qualitatively differ between transparent and opaque orthographies. *Journal of Educational Psychology*, *102*(4), 827.

Van de Vijver, F., & Tanzer, N. K. (1997). Bias and equivalence in cross-cultural assessment. *European review of applied psychology*, *47*(4), 263-279.

Vargha, A., & Delaney, H. D. (1998). The Kruskal-Wallis test and stochastic homogeneity. *Journal of Educational and behavioral Statistics*, *23*(2), 170-192.

Veii, K., & Everatt, J. (2005). Predictors of reading among Herero-English bilingual Namibian school children. *Bilingualism*, *8*(3), 239.

Vellutino, F. R., & Fletcher, J. M. (2005). *Developmental Dyslexia.* In M. J. Snowling & C. Hulme (Eds.), *Blackwell handbooks of developmental psychology. The science of reading: A handbook* (p. 362–378). Blackwell Publishing.

Vellutino, F. R., Tunmer, W. E., Jaccard, J. J., & Chen, R. (2007). Components of reading ability: Multivariate evidence for a convergent skills model of reading development. *Scientific studies of reading*, *11*(1), 3-32.

Wagner & Skowronski in Reliability and Validity of Measurement in the Social and Behavioral Sciences. (2019). In J. Edlund & A. Nichols (Eds.), Advanced Research Methods for the Social and Behavioral Sciences (pp. 21-37). Cambridge: Cambridge University Press.

Wagner, D. A., Spratt, J. E., & Ezzaki, A. (1989). Does learning to read in a second language always put the child at a disadvantage? Some counterevidence from Morocco. *Applied Psycholinguistics*, *10*(1), 31-48.

Wagner, R. K., & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological bulletin*, *101*(2), 192.

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1994). Development of reading-related phonological processing abilities: New evidence of bidirectional causality from a latent variable longitudinal study. *Developmental psychology*, *30*(1), 73.

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1999). Comprehensive Test of Phonological Processing (CTOPP). Austin, TX: Pro-Ed.

Wang, J., Joanisse, M. F., & Booth, J. R. (2018). Reading skill related to left ventral occipitotemporal cortex during a phonological awareness task in 5–6-year old children. *Developmental cognitive neuroscience*, *30*, 116-122.

Wang, M., & Geva, E. (2003). Spelling acquisition of novel English phonemes in Chinese children. *Reading and Writing*, *16*(4), 325-348.

Wasik, B. A., Hindman, A. H., & Snell, E. K. (2016). Book reading and vocabulary development: A systematic review. *Early Childhood Research Quarterly*, *37*, 39-57.

Wechsler, D. (2003). Wechsler intelligence scale for children (4th ed.). San Antonio, TX: Psychological Corporation.

Weir, S., Archer, P., & Millar, D. (2009). *Educational disadvantage in primary schools in rural areas. Report No. 1: Analysis of English reading and mathematics achievement in schools in the rural dimension of the School Support Programme.* Report to the Department of Education and Science. Dublin: Educational Research Centre.

Westen, D., & Rosenthal, R. (2003). Quantifying construct validity: two simple measures. *Journal of personality and social psychology*, *84*(3), 608.

Wilkinson, L. (1999). Task Force on Statistical Inference, American Psychological Association, Science Directorate.(1999). Statistical methods in psychology journals: Guidelines and explanations. *American Psychologist*, *54*(8), 594-604.

Winter, B. (2019). *Statistics for linguists: An introduction using R*. Routledge.

Wolf, M., & Bowers, P. G. (1999). The double-deficit hypothesis for the developmental dyslexias. *Journal of educational psychology*, *91*(3), 415.

Wolff, U. (2014). RAN as a predictor of reading skills, and vice versa: Results from a randomised reading intervention. *Annals of Dyslexia*, *64*(2), 151-165.

Yang, Y., Yang, Y. H., Li, J., Xu, M., & Bi, H. Y. (2020). An audiovisual integration deficit underlies reading failure in nontransparent writing systems: An fMRI study of Chinese children with dyslexia. *Journal of Neurolinguistics*, *54*, 100884.

Yopp, H. K. (1988). The validity and reliability of phonemic awareness tests. *Reading Research Quarterly*, 159-177.

Ziegler, J. C., & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: a psycholinguistic grain size theory. *Psychological bulletin*, *131*(1), 3.

Ziegler, J. C., Bertrand, D., Tóth, D., Csépe, V., Reis, A., Faísca, L., ... & Blomert, L. (2010). Orthographic depth and its impact on universal predictors of reading: A cross-language investigation. *Psychological science*, *21*(4), 551-559.

Ziegler, J. C., Stone, G. O., & Jacobs, A. M. (1997). What is the pronunciation for-ough and the spelling for/u/? A database for computing feedforward and feedback consistency in English. *Behavior Research Methods, Instruments, & Computers*, *29*(4), 600-618.

Zutell, J., & Allen, V. (1988). The English spelling strategies of Spanish-speaking bilingual children. *TESol Quarterly*, *22*(2), 333-340.

APPENDIX 1: LETTER CONFIRMING ETHICAL APPROVAL

19/04/2018

Application: Academic Year 2017/18

Title of Research: Cognitive processes in Irish literacy

Applicant: HT42 Barnes, Emily

Dear Emily,

Your revised submission for ethics approval for the research project above was considered by the Research Ethics Committee, School of Linguistic, Speech and Communication Sciences, Trinity College Dublin, on Tuesday 10th April 2018, and has been approved in full. We wish you the very best in your research activities.

Please note that on completion of research projects, applicants should complete the End of Project Report Form and submit one signed hard copy to the School Office as well as an electronic copy (slcsc@tcd.ie).

Best wishes,

Professor John Saeed

Chair, Research Ethics Committee
School of Linguistic, Speech and Communication Sciences

APPENDIX 2: CONSENT FORM FOR PRE-TEST 1 AND PRE-TEST 2

Pilot-testing verbal and literacy tasks: Consent Form

School of Linguistics, Speech and Communication Sciences, Trinity College Dublin.
Emily Barnes (PhD researcher), Professor Ailbhe Ní Chasaide and Professor Neasa Ní Chiaráin

My child has been invited to take part in a pilot test of verbal and literacy exercises. The aim of the pilot test is to ensure that the exercises, which will be later used in a larger study, are at an appropriate level of difficulty for pupils and to see how long the exercises take to complete. My child's participation is voluntary, and even if I decide to let him or her participate now, I can change my mind at any time with no consequences.

Tasks

If I agree to let my child participate, (s)he will be asked to complete some verbal exercises which include playing with the sounds of words (e.g. taking the *t* in *train* away to make a new word) and a reading and spelling task. This will take about 30 minutes.

Audio recording

The answers the children give during the exercises will be recorded. The recording will only be used by the researcher to check if her own record of the responses is correct.

Risks and Benefit

This pilot test does not involve any level of risk beyond that of a normal school day. However, I am aware that the time commitment may by inconvenient to my child as it will take about 30 minutes from their school day. If I am anxious about any aspect of the pilot test, or if my child is worried, I can speak with the researchers involved.

My child will not benefit directly from this pilot test, but the findings are essential for the success of the larger study. This will take place after Christmas in other Gaelscoileanna, and will contribute to the understanding of what skills and abilities help children in Gaelscoileanna to learn to read and write.

Confidentiality

Any information or data which relates to my child will be completely confidential.

Questions

If I have any questions, I can contact the researchers (Emily at ebarnes@tcd.ie or Professor Ailbhe Ní Chasaide at anichsid@tcd.ie) and expect a quick answer.

Signature of participant's parent/guardian

I understand what is involved in this pilot study and I agree to allow my child to participate.

---------- ----------

Signature of participant's parent/guaridan Date

APPENDIX 3: SAMPLE OF DATA COLLECTION TOOL USED IN PRE-TEST 1 AND PRE-TEST 2

Task: _____

Class group: _____

Difficulty

Rate the **difficulty level** of this task for this agegroup

Very easy	Easy	Appropriate	Difficult	Very difficult
☐	☐	☐	☐	☐

Was there evidence of **ceiling** effects? (where most pupils could read every word on the list)

Yes	No
☐	☐

Was there evidence of **floor** effects? (where most pupils could not read any word on the list)

Yes	No
☐	☐

Did the pupils find one version of the task (Irish or English) **more difficult** that the other?

Irish version was more difficult for them	☐
English version was more difficult for them	☐
The Irish version and English version were the same level of difficulty	☐

Instructions

Rate the clarity of the instructions provided to children before starting the task

Very clear	Clear	Average	Unclear	Very unclear
☐	☐	☐	☐	☐

Do most children understand how to perform the task from the instructions provided to them before they begin the task?

Yes	No
☐	☐

Practice items

Is the practice item sufficient for the children to understand what is required?

Yes	No
☐	☐

Behavioural Observation

Are the children happy to complete the task?

Yes	No
☐	☐

Is any aspect of the task causing them trouble?

Yes	No
☐	☐

Is **yes**, please explain:

Improvement

Could any aspect of the task be improved upon? (For example: approach to task, instructions, number of practice items, words used in the task)

APPENDIX 4: SAMPLE OF RECORD BOOK (ENGLISH VERSION)

Record Book

First Class

Participant Number: _____

Peter Penguin (Linguistic phonemic awareness task)

	C match		C mismatch		Vowel match		Vowel mismatch	
1	**Ring – wrist**							
2			*Family – table*					
3			*Giraffe – garden*					
4	*Photo - farmer*							
5			**Photo – postman**					
6	**Sunny - supper**							
7							Ostrich-open	
8							Apple-otter	
9					Open-over			
10	**Jelly - gentle**							
11	*River - robin*							
12			**Rabbit - candle**					
13			*Sandal - biscuit*					
14					Apple - actor			
15	*Circle- sailor*							
16			*Water - writing*					
17			**Jungle - puppy**					
18					Otter - ostrich			
19	**Finger - fishing**							
20							Actor - angel	
21					Apron - angel			
22			**Sugar - sunny**					
23							Oval - acorn	
24	*Jewel - jacket*							
	A		**B**		**C**		**D**	
Total match (A + C)								
Total mismatch (B + D)								
Ortho mismatch (grey)								
Ortho match (white)								
CV match (bold in A)								
CV mismatch (bold in B)								
Phoneme (italic in A)								
Phoneme mismatch (italic in B)								

The Word Wizard (metalinguistic phonemic awareness task)

	Stimulus		**Score (1/0)**
1	sand		
2	witch		
3	book		
4	toy		
5	me		
		Subtotal	
1	clock		
2	troll		
3	snake		
4	frog		
		Subtotal	
1	loaf		
2	box		
3	food		
4	rocks		
		Subtotal	
Total			

Word Race (Rapid automatised naming task)

Time (seconds)	
Notes	

Parrot Game (Verbal short-term memory task)

No. of words		Score
2	Egg; ball	
3	Egg; ball; bus	
4	Egg; ball; bus; hat	
5	Egg; ball; bus; hat; boot	
6	Egg; ball; bus; hat; boot; sky	
7	Egg; ball; bus; hat; boot; sky; goat	
8	Egg; ball; bus; hat; boot; sky; goat; pig	
Total (no. of words)		

Word Reading

Word	Answer		Nonword	Answer	
mud			world		
cat			pencil		
pet			family		
rug			sister		
big			snake		
lamp			bread		
park			house		
cold			donkey		
water			pancake		
boot			wednesday		
feet			brush		
pool			lunch		
paint			summer		
sleep			chicken		
slide			birthday		
ball			busy		
teddy			school		
happy			cabbage		
box			lightning		
sheep			cupboard		

Spelling

Spelling	Answer	1/0
red		
tap		
Arm		
Party		
Sink		
Rope		
Boat		
mess		

APPENDIX 5: WORD READING TASK STIMULI

Irish word reading stimuli

Grade 2 Irish word reading
bád
bus
lón
muc
cóta
hata
gúna
mála
cara
cáca
cupán
doras
solas
gorm
bróga
buí
teidí
dearg
scoil
ubh

Grade 3 Irish word reading	
bád	**madra**
bus	**lampa**
lón	**bosca**
muc	**bábóg**
cóta	**siopa**
hata	**spéir**
gúna	**siúcra**
mála	**cailín**
cara	**citeal**
cáca	**cairde**
cupán	**milseán**
doras	**eitleán**
solas	**caisleán**
gorm	**geansaí**
bróga	**rothar**
buí	**nuachtán**
teidí	**fáinne**
dearg	**dochtúir**
scoil	**buachaill**
ubh	**pióg**

One letter-one sound
Contain non-articulated vowels which signal consonant quality
Contain two consonantal letters representing one sound
Contain non-articulated vowels *and* two consonantal letters representing one sound
Follow complex or unusual rules

English word reading stimuli

Grade 3 English word reading	
mud	**world**
cat	**pencil**
pet	**family**
rug	**sister**
big	**snake**
lamp	**bread**
park	**house**
cold	**donkey**
water	**pancake**
boot	**wednesday**
feet	**brush**
pool	**lunch**
paint	**summer**
sleep	**chicken**
slide	**birthday**
ball	**busy**
teddy	**school**
happy	**cabbage**
box	**lightning**
sheep	**cupboard**

One letter-one sound
Contain two vowel letters representing one sound
Contain two consonantal letters representing one sound
Contain two vowel letters representing one vowel sound *and* two consonantal letters representing one sound
Follow unusual rules or do not follow any rules

APPENDIX 6: SAMPLE OF LETTER AND INFORMATION LEAFLET SENT TO PRINCIPALS

An tSaotharlann Foghraíochta agus Urlabhra,
Seomra 4074A,
Scoil na nEolaíochtaí Teangeolaíochta,
Urlabhra agus Cumarsáide,
Coláiste na Tríonóide

A chara,

Tá staidéar ar shealbhú na litearthachta sa Ghaeilge á reáchtáil ag taighdeoirí de chuid An tSaotharlann Foghraíochta agus Urlabhra, Coláiste na Tríonóide, agus ba mhór againn [SCOIL] a bheith páirteach ann. Tá an staidéar dírithe ar na próisis chognaíocha a éascaíonn sealbhú na litearthachta sa Ghaeilge. Is beag taighde atá déanta sa réimse seo, agus tabharfaidh torthaí an staidéir seo bonn eolais níos leithne dúinn le scagthástáil agus acmhainní luathlitearthachta a fhorbairt.

Tá sonraí an staidéir ar fáil sna bróisiúir iniata. Iarrtar ar scoláirí sna Naíonáin Bheaga, sna Naíonáin Mhóra, agus i Rang a hAon páirt a ghlacadh ann. Is le linn an ghnáthlá scoile a reáchtálfar an staidéar, agus is féidir le lucht na scoile dátaí a roghnú a oireann dóibh féin. Tiocfaidh taighdeoir amach chuig an scoil chun na tascanna a dhéanamh leis na páistí rannpháirteacha idir Mí Eanáir agus Mí an Mheithimh 2019, agus leanfaidh gach seisiún thart ar 30 nóiméad.

Más mian leat go mbeidh do scoil páirteach sa staidéar, nó má tá tuilleadh eolais uait, cuir ríomhphost chuig ebarnes@tcd.ie nó breathnaigh ar shuíomh gréasáin an staidéir www.gael-literacy.weebly.com.

Le gach dea-ghuí,

_____

Emily Barnes
Taighdeoir dochtúireachta
An tSaotharlann Foghraíochta agus Urlabhra, Coláiste na Tríonóide.

An gcoinneofar sonraí na rannpháirtithe faoi rún?

Coinneofar, cinnte. Ní bheidh éinne in ann fáil amach cén chaoi a n-eiríonn le rannpháirtí ar bith, ach amháin an taighdeoir a dhéanann na tascanna leis an scoláire.

An mbeidh ainm na scoile luaite i bpáipéir acadúla nó ag comhdhálacha?

Ní bheidh ainm na scoile luaite áit ar bith, agus ní dhéanfar aon chomparáid idir scoileanna éagsúla. Cuirfear rannpháirtithe i gcatagóirí éagsúla de réir an teanga/na teangacha atá acu sa bhaile agus ar scoil.

Ar mhaith leat a bheith páirteach?

Má tá suim agat a bheith páirteach sa staidéar, cuir ríomhphost chuig Emily (ebarnes@tcd.ie).

Cuirfear foirmeacha toilithe agus bileoga eolais chuig na scoileanna rannpháirteacha sna míonna atá amach romhainn.

Beidh na taighdeoirí atá páirteach sa staidéar sásta teacht amach go dtí an scoil agus ceisteanna a fhreagairt sula dtosaíonn an staidéar.

Aon cheist eile?

Má tá ceist ar bith agat, ná bíodh drogall ort dul i dteagmháil leis na taighdeoirí ag na seoltaí seo a leanas:

Emily Barnes (ebarnes@tcd.ie)
Ailbhe Ní Chasaide(anichsid@tcd.ie)
Neasa Ní Chiaráin (nichiarn@tcd.ie)

**Scoil na nEolaíochtaí Teangeolaíochta, Urlabhra agus Cumarsáide,
Coláiste na Tríonóide.**

**Emily Barnes (mac léinn PhD)
An t-Ollamh Ailbhe Ní Chasaide
An t-Ollamh Neasa Ní Chiaráin**

IRISH RESEARCH COUNCIL
An Chomhairle um Thaighde in Éirinn

Staidéar
Cumas litearthachta a thuar i bpáistí i nGaelscoileanna agus i scoileanna Gaeltachta

Bileog Eolais do Phríomhoidí agus do Mhúinteoirí

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Cad í aidhm an staidéir seo?

Is í aidhm an staidéir seo ná an nasc idir scileanna áirithe – an fheasacht fóineolaíochta, an chuimhne fheidhmiúil agus luas próiseála – agus an litearthacht a fhiosrú sa Ghaeilge.

Cén fáth?

Is féidir tástáil a dhéanamh ar na scileanna seo le cumas litearthachta a thuar i bpáistí óga, rud a dhéantar i dteangacha eile. Ní hionann an nasc idir na scileanna seo agus an litearthacht ó theanga go céile, áfach; tá nasc níos láidre idir an fheasacht fóineolaíochta agus an litearthacht sa Bhéarla, ná mar atá i dteangacha eile, cuir i gcás.

Ba mhaith linn an nasc idir na scileanna seo agus an litearthacht a fhiosrú sa Ghaeilge. Fágfaidh sé sin go mbeimid in ann scagthástail a fhorbairt atá bunaithe ar thaighde, do pháistí i nGaelscoileanna agus scoileanna Gaeltachta.

Creidimid gur chóir go mbeadh fáil ag gach páiste sa chóras Gaeloideachais ar scagthástáil atá bunaithe ar thaighde, mar atá ar fáil sa Bhéarla.

Cad atá i gceist leis an staidéar?

Iarrfar ar scoláirí sna Naíonáin Bheaga, sna Naíonáin Mhóra agus i Rang a hAon a bheith páirteach sa staidéar.

Iarrfar ar na rannpháirtithe na tascanna seo a leanas a dhéanamh sa Ghaeilge agus sa Bhéarla.

An fheasacht fóineolaíochta
Éisteann an rannpháirtí le focal agus baineann sí nó sé fuaim amháin de e.g. “abair *bus* gan an *b*”.

An chuimnhe fheidhmiúil
Éisteann an rannpháirtí le sraith uimhreacha, agus deir sí nó sé an tsraith ina dhiaidh.

Luas próiseála
Ainmníonn an rannpháirtí pictiúir de rudaí coitianta.

An litearthacht
Léann an rannpháirtí liosta focal agus litríonn sí nó sé liosta focal.

Iarrfar ar thuismitheoirí nó caomhnóirí ceistneoir gairid a líonadh (5-10 nóiméad atá i gceist leis) maidir leis an taithí atá ag an rannpháirtí leis an nGaeilge.

Cé mhéad ama a bheas i gceist?

Is staidéar fadama é seo. Iarrfar ar rannpháirtithe na tascanna a dhéanamh

- uair amháin idir Mí Eanáir agus Mí an Mheithimh 2019;
- uair amhain idir Mí Eanáir agus Mí an Mheithimh 2020.

Leanfaidh an seisiún thart ar 30 nóiméad i ngach cás, agus déanfar an staidéar le linn an ghnáthlá scoile.

Is féidir le príomhoidí agus le múinteoirí seachtain a roghnú a oireann dóibh féin agus dá scoláirí.

APPENDIX 7: SAMPLE OF LETTER INFORMATION LEAFLET, CONSENT FORM AND BACKGROUND QUESTIONNAIRE SENT TO PARENTS

Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

IRISH RESEARCH COUNCIL
An Chomhairle um Thaighde in Éirinn

A thuismitheora/a chaomhnóra, a chara,

Iarrtar ar dhaltaí _____ a bheith páirteach i staidéar atá á reachtáil ag taighdeoirí de chuid Choláiste na Tríonóide. Is í aidhm an staidéir ná an nasc idir cumais áirithe labhartha agus an litearthacht a fhiosrú. Ligfidh an t-eolas sin do thaighdeoirí scagthástáil litearthachta a dhearadh do pháistí sa chóras Gaeloideachais.

Tá sonraí an staidéir ar fáil sa bhileog eolais atá iniata leis seo; is féidir an t-eolas sin a léamh agus más mian leat go mbeidh do pháiste páirteach sa staidéar, bheimid buíoch díot as:

1. An fhoirm toilithe a shíniú;
2. An leathanach eolais a líonadh amach;
3. An clúdach litreach a shéaladh agus a thabhairt don mhúinteoir ranga faoin **30 Samhain**

Tiocfaidh taighdeoir isteach go dtí an scoil (dátaí thíos) agus déanfaidh sí na tascanna le do pháiste uair amháin le linn na bliana acadúla seo, agus uair amháin le linn na bliana acadúla seo chugainn.

Rang	**Seachtain dar tús:**
Naíonáin shóisearacha	
Naíonáin shinsearacha	
Rang a hAon	

Cuirtear fáilte roimh cheisteanna – is féidir dul i dteagmháil le hEmily ag ebarnes@tcd.ie.

Le gach dea-ghuí,

Emily Barnes, Prof. Ailbhe Ní Chasaide, Prof. Neasa Ní Chiaráin.
Phonetics and Speech Laboratory, Trinity College Dublin

Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

IRISH RESEARCH COUNCIL
An Chomhairle um Thaighde in Éirinn

Dear Parent/Guardian,

Pupils of _____ are invited to take part in a study being carried out by researchers of Trinity College, Dublin. This research investigates the link between certain verbal abilities and learning to read and write. The results of the study will allow researchers to develop a literacy screening test for children in Gaelscoileanna and scoileanna Gaeltachta.

You will find additional information in the leaflet enclosed; please read the information leaflet, and if you would like your child to take part please:

1. Sign the consent form
2. Fill out the information sheet
3. Seal the envelope and return it to the class teacher **by the 30th of November**

A researcher from the Phonetics and Speech Laboratory will come to the school and carry out the tasks with your child once during the current academic year (see dates above) and once during the next academic year.

Class	**Week beginning:**
Naíonáin shóisearacha	
Naíonáin shinsearacha	
Rang a hAon	

If you have any questions, feel free to contact Emily at ebarnes@tcd.ie.

Le gach dea-ghuí,

Emily Barnes, an t-Ollamh Ailbhe Ní Chasaide, an t-Ollamh Neasa Ní Chiaráin.
An tSaotharlann Foghraíochta agus Urlabhra, Coláiste na Tríonóide

Will the participants' performance be confidential?

Absolutely. Apart from the researcher carrying out the tasks, no one will be able to see how any participant performed. This study is not concerned with the performance of individuals, but with the relationship between certain abilities and literacy in different groups of people.

Does my child have to take part?

Not at all. Your child's participation is voluntary and even if you decide to allow them to participate now, you can change your mind at any time.

Any questions?

If you have any questions, please feel free to contact the researchers. You can contact Emily Barnes at ebarnes@tcd.ie, Ailbhe Ní Chasaide at anichsid@tcd.ie, or Neasa Ní Chiaráin at nichiarn@tcd.ie.

School of Linguistic, Speech and Communication Sciences, Trinity College Dublin

Emily Barnes (PhD student)
Professor Ailbhe Ní Chasaide
Professor Neasa Ní Chiaráin

IRISH RESEARCH COUNCIL
An Chomhairle um Thaighde in Éirinn

Predictors of literacy ability:
children in Irish-medium education

Information Leaflet for Parents and Guardians

Coláiste na Tríonóide, Baile Atha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

An tSaotharlann Foghraíochta agus Urlabhra
Phonetics and Speech Laboratory

What is the aim of the study?

The aim of this study is to find out whether certain skills or abilities (such as awareness of the sounds of language, or speed of processing) are related to learning to read and write in the Irish language.

The results of this study will help us to (a) develop a screening test to help identify reading difficulties at an early age, and (b) develop teaching materials for early literacy in Irish.

This project is driven by the conviction that children in Gaeltacht schools and in Gaelscoileanna deserve the same access to research-based literacy screening as is available in English.

What does the study involve?

If you would like your child to take part, you are asked to sign the consent form and fill in the information sheet (enclosed) on your child's experience with Irish. This will take about 5 minutes.

Then, your child will complete some tasks (described below) in Irish and English. This will take 25 – 30 minutes and will take place in school.

Phonological awareness tasks
Tasks relating to the sounds of language, and the ability to identify sounds or delete sounds in a word.

Speed of processing tasks
Tasks relating to the speed with which objects can be named.

Literacy task
(except Junior Infants)
A reading and spelling task

An audio recorder will record the participants' responses to the tasks. The recording will only be used by the researchers to check if their own written record of the responses is accurate.

How much of a time commitment is involved?

This is a longitudinal study, and children will be asked to complete the tasks

- on one occasion between January and June 2019.
- on one occasion between January and June 2020.

Are there any risks involved?

This study consists of verbal tasks and does not involve any level of risk beyond that of a normal school day. However, the time commitment involved may inconvenience you and your child.

Will the study benefit my child?

This study will not directly benefit your child, however this research will contribute to our understanding of the process of literacy acquisition in Irish, and allow us to develop appropriate early literacy materials for Gaelscoileanna and scoileanna Gaeltachta.

Predictors of literacy ability in the Irish language: Consent Form

School of Linguistics, Speech and Communication Sciences, Trinity College Dublin.
Emily Barnes (PhD researcher), Professor Ailbhe Ní Chasaide and Assistant Professor Neasa Ní Chiaráin

My child is invited to take part in this study, which investigates the link between certain skills and literacy ability in the Irish language. My child's participation is voluntary, and even if I decide to let him or her participate now, I can change my mind at any time with no consequences.

Tasks

If I agree to let my child participate, I am asked to fill out an information sheet about their exposure to Irish (which will take about 5 minutes). Then, my child will be asked to complete a number of tasks at school (described in the information leaflet) which will take 25 - 30 minutes with breaks included. As this is a longitudinal study, my child will be asked to complete these tasks once in 2019, and once in 2020.

Audio recording

If I agree to participate, my child's responses to the tasks will be recorded. The recording will only be used by the researcher to check if her own record of the responses is correct.

Risks and Benefit

This study does not involve any level of risk beyond that of a normal school day. However I am aware that the time commitment may by inconvenient to my child as it will take about 30 minutes from their school day. Participating in studies can cause some children to be nervous; if I am anxious about any aspect of the study, or if my child is worried, I can speak with the researchers involved.

My child will not benefit directly from this study, but the findings of this study will contribute to the understanding of what skills and abilities help children in Gaelscoileanna and scoileanna Gaeltachta to learn to read and write.

Confidentiality

Any information or data which relates to my child will be completely confidential. If the findings of this study are published, there will be no mention of individual participants and the name of the school will not be mentioned.

Questions

If I have any questions, I can contact the researchers (Emily at ebarnes@tcd.ie or Professor Ailbhe Ní Chasaide at anichsid@tcd.ie) and expect a quick answer.

Signature of participant's parent/guardian

I understand what is involved in this research and I agree to allow my child to participate in the study.

---------- ----------

Signature of participant's parent/guardian Date

Signature of researcher

I believe the participant's parent or guardian is giving informed consent for them to participate in this study.

---------- ----------

Signature of researcher Date

Participant's language and educational background

The information provided below is confidential, and will only be used when analysing the data collected for this study. It will not be shared with the school or with any other party.

Participant's details

Name:	
Date of birth:	
Gender:	
Class group:	

Early childhood education

1. Did your child attend any form of early childhood education (i.e. pre-school, playschool or montessori)?
   ☐ Yes ☐ No

2. If you answered yes to Q.1 above, please indicate what the main language of education was:
   ☐ Irish language ☐ English language ☐ Another language: _____

Languages spoken in the home

- **This section relates to the participant's parent(s)/guardian(s) and the languages they speak to the child**

Parent/Guardian A

Relationship to the child: _____ **Native language:** _____

Home languages: how often do you speak the following languages to the child?

	Always	Very often	Half the time	Rarely	Never
Irish	☐	☐	☐	☐	☐
English	☐	☐	☐	☐	☐
Other: _____	☐	☐	☐	☐	☐

Language of education: please indicate the language of your education (for the levels that apply)

Primary	☐ English	☐ Irish	☐ Other language:
Secondary: Junior Certificate	☐ English	☐ Irish	☐ Other language:

Secondary: Leaving Certificate	☐ English	☐ Irish	☐ Other language:
University	☐ English	☐ Irish	☐ Other language:

Parent/Guardian B (optional)

Relationship to the child: _____

Native language: _____

Home languages: how often do you speak the following languages to the child?

	Always	Very often	Half the time	Rarely	Never
Irish	☐	☐	☐	☐	☐
English	☐	☐	☐	☐	☐
Other: _____	☐	☐	☐	☐	☐

Language of education: please indicate the language of your education (for the levels that apply)

Primary	☐ English	☐ Irish	☐ Other language: ___
Secondary: Junior Certificate	☐ English	☐ Irish	☐ Other language: ___
Secondary: Leaving Certificate	☐ English	☐ Irish	☐ Other language: ___
University	☐ English	☐ Irish	☐ Other language: ___

Learning differences

1. Does your child have a learning difference or a behavioural difference which could affect their performance on a spoken language task or reading task?
   Yes ☐ No ☐

2. If you answered yes to Q.1 above, please indicate the type of learning or behavioural difference:
   - ☐ A language or speech impairment
   - ☐ Dyslexia
   - ☐ Any other developmental disorder (such as dyspraxia, dyscalculia etc.)
   - ☐ ADHD
   - ☐ Autism
   - ☐ Other _____

Additional comments

If you would like to provide any additional information on any of the questions above, or if you would like to make any other comment you can do so below:

Go raibh míle maith agat!

APPENDIX 8: DATA COLLECTION SCHEDULE

Week beginning	Age group	School type
7/1/19	Grade 3	GS
14/1/19	Grade 3	GS
21/1/19	Grade 3	GS
28/1/19	Grade 3	GS
4/2/19	Grade 3	GS
11/2/19	Grade 2	GS
18/2/19	*Mid-term break*	
25/2/19	Grade 2	GS
4/3/19	Grade 2	GS
11/3/19	Grade 2	GS
18/3/19	Grade 2	GS
25/3/19	Grade 3/Grade 2	GT
1/4/19	Grade 3/Grade 2	GT
8/4/19	Grade 2/Grade 1	GT
15/4/19	*Easter break*	
22/4/19	*Easter break*	
29/4/19	Grade 2/Grade 1	GT
6/5/19	Grade 1	GS
13/5/19	Grade 1	GS
20/5/19	Grade 1	GS
27/5/19	Grade 1	GS
03/06/19	Grade 1	GS

APPENDIX 9: ERRORS MADE ON IRISH SPELLING TASK

Note: there are multiple errors in many of the examples provided. The error relevant to the category cited is in bold font.

Type of error	Examples
Rós (28 errors)	
20 vowel grapheme substitution	
16 long-short vowels	r**o**s
2 alternative spelling (English)	ros**e**
1 unexplained	r**u**ss
1 a/o	r**a**
4 consonant grapheme substitution	
3 alternative spelling	ró**z**
1 unexplained	ro**v**
3 consonant grapheme addition	
2 geminates	ros**s**
1 unexplained	ros**h**
1 consonant grapheme omission: unexplained	ra
1 multiple/complex (no graphemes correct; *excluded from analysis*)	fol
Cás (33 errors)	
22 vowel grapheme substitutions	
13 a/o	c**o**s, cós
8 long-short vowels	c**a**s
1 unexplained	c**r**s
6 consonant grapheme additions	
2 séimhiú	c**h**ás
1 geminate	cas**s**
3 unexplained	co**r**s
3 vowel grapheme addition: unexplained	cás**a**
1 vowel grapheme omission: unexplained	cs
1 consonant grapheme substitution: unexplained	ca**r**
Trá (40 errors)	
13 consonant grapheme omissions:13 cluster	tá
11 vowel grapheme substitutions:	
7 a/o	tr**o, t**ó
3 long-short vowels	t**a**
1 unexplained	t**í**r
8 consonant grapheme addition:	
5 unexplained	trá**n**, trá**h**
2 séimhiú	t**h**rá
1 geminate	tr**r**á
5 consonant grapheme substitutions: 5 unexplained	**c**ro
2 grapheme transpositions: 2 cluster	**tor**
1 vowel grapheme addition: unexplained	crá**e**

1 multiple/complex (no graphemes correct; excluded from analysis)	so
Sásta (61 errors)	
22 vowel substitutions	
10 long-short vowels	s**a**sta
8 a/o	s**o**sta
4 unstressed position	sost**e**
19 consonant grapheme omissions: cluster	sása, sáta
7 vowel grapheme omissions: unstressed position	sást
6 consonant grapheme substitutions: voicing	sás**d**a
3 consonant grapheme additions: unexplained	s**t**ásta
2 consonant grapheme transpositions: cluster	sas**at**
2 vowel grapheme addition: unexplained	sá**i**te
Súil (99 errors)	
68 vowel grapheme omission	
66 consonant quality marker	súl
2 unexplained	sl
16 vowel grapheme substitutions	
8 long-short vowels	s**u**l
2 alternative spellings in English	sul**e**, s**oo**l
6 unexplained	s**au**l
10 consonant grapheme additions	
8 geminates	súl**l**
1 alternative spelling	sú**mh**l
1 unexplained	su**w**ul
3 vowel grapheme additions	
3 unexplained	siu**i**l, súl**a**
1 consonant grapheme omission: unexplained	sa
1 consonant grapheme substitution: unexplained	**l**úl
Fear (127 errors)	
82 vowel grapheme omission:	
72 consonant markers	far
7 letter names	fr
3 unexplained	fer
30 vowel grapheme substitutions	
9 a/o	f**o**r
7 long-short	f**á**r, f**é**ar
9 unexplained	f**u**r
5 consonant markers	fe**i**r
7 grapheme transpositions: unexplained	fer**a**
6 consonant grapheme additions	
4 geminates	far**r**
1 séimhiú	f**h**ar
1 unexplained	f**r**ar
2 consonant grapheme omissions: 2 unexplained	fá
Carr (80 errors)	
50 consonant grapheme substitutions: 50 geminates	ca**r**, cár

23 vowel grapheme substitutions	
11 alternative spelling: replacing geminate	c**á**r
1 alternative spelling	c**á**rr
8 unexplained	c**u**rr
3 a/o	c**o**rr
2 vowel grapheme omissions: 2 letter name	c**r**
2 vowel grapheme additions (unexplained)	c**e**or
2 consonant grapheme additions (séimhiú)	c**h**arr
1 grapheme transposition: unexplained	c**ra**
Dubh (86 errors)	
52 consonant grapheme substitution:	
22 alternative spelling: English	du**v**
11 letter reversal	**b**ubh
10 voicing	du**f**
6 unexplained	du**y**
2 alternative spelling	du**mh**
25 vowel grapheme substitution:	
20 alternative spelling	d**o**bh
3 long-short vowels	d**ú**v
2 unexplained	d**ó**bh
2 consonant grapheme omissions: 2 unexplained	bu
3 consonant grapheme additions	
2 séimhiú	d**h**ubh
1 unexplained	**t**duhe
3 vowel grapheme additions: 3 unexplained	du**a**bh
1 grapheme transposition: unexplained	du**hb**

APPENDIX 10: ERRORS MADE ON ENGLISH SPELLING TASK

Note: there are multiple errors in many of the examples provided. The error relevant to the category cited is in bold font.

Type of error	Examples
Red (17 errors)	
10 vowel grapheme substitutions: unexplained	r**u**d, r**a**d
6 consonant grapheme substitutions	
3 letter reversals	re**b**
2 voicing	ra**t**
1 unexplained	ra**y**
1 vowel grapheme addition: geminate	re**e**d
Tap (13 errors)	
10 consonant grapheme substitutions	
7 letter reversals	ta**q**
2 unexplained	**b**a**u**
1 voicing	**d**ap
1 consonant grapheme addition (geminate)	tap**p**e
1 vowel grapheme addition (final -e)	tapp**e**
1 vowel grapheme substitution (a/o)	t**o**q
Arm (47 errors)	
25 vowel grapheme substitutions	
18 a/o	**o**rm
5 unexplained	**u**rm
1 alternative spelling	**our**m
1 alternative spelling in Irish	r**á**m
8 vowel grapheme ommissions: 8 letter name substitutions	**r**m
5 grapheme transpositions: 5 cluster	**ra**m
5 vowel grapheme addition:	
3 final -e	arm**e**
2 unexplained	ar**e**m
4 consonant grapheme omissions: 4 cluster	om
Party (104 errors)	
42 vowel grapheme substitutions	
24 letter name	part**e**
9 a/o	p**o**rty
6 alternative spelling	port**ee**
1 alternative spelling in Irish	bart**í**
2 unexplained	prt**i**
38 vowel grapheme omissions	
35 letter name	prty
3 unexplained	prr
9 consonant grapheme additions:	
8 geminates	pa**rr**ty

1 unexplained	p**r**arty
6 consonant grapheme omissions: 6 cluster	pate
3 consonant grapheme substitutions: voicing	**b**arty
3 vowel grapheme additions	
2 unexplained	part**i**y
1 alternative spelling	part**ey**
3 grapheme transpositions: cluster	p**rat**y
Sink (93)	
37 consonant grapheme substitutions	
36 alternative spelling	sin**c**
1 unexplained	sin**j**
24 consonant grapheme omissions: 24 cluster	sic
27 consonant grapheme additions	
25 alternative spelling	si**ng**k
2 unexplained	s**h**inc
2 vowel grapheme additions: 2 final -e	sink**e**
3 vowel grapheme substitutions (3 unexplained)	s**e**k, s**a**nc
Rope (64 errors)	
54 vowel grapheme substitutions	
42 long-short vowel	r**o**p
6 a/o	ro**o**p
4 alternative spelling	r**oa**p
2 alternative spelling in Irish	r**ó**p
3 vowel grapheme omission: unexplained	rp
1 consonant grapheme substitutions: letter reversal	ro**q**
1 consonant grapheme omission: unexplained	ra
3 consonant grapheme additions	
1 unexplained	r**h**op
1 alternative spelling	ro**w**p
1 geminate	rop**p**
2 vowel grapheme addition: unexplained	**a**roop
Boat (76 errors)	
70 vowel grapheme substitutions	
35 long-short vowels	b**o**t
23 alternative spelling	bot**e**
3 unexplained	bo**u**t
2 alternative spelling in Irish	b**ó**t
7 a/o	bo**o**t
3 consonant grapheme substitutions	
2 letter reversals	**d**ot
1 voicing	ba**d**
3 consonant grapheme additions:	
2 unexplained	bod**t**
1 geminate	bot**t**e
Mess (74 errors)	
66 consonant grapheme substitution: geminate	
62 geminates	me**s**

4 unexplained	**n**os, mesh
2 vowel grapheme addition: geminate	me**e**s
6 vowel grapheme substitution: unexplained	m**i**ss