

11 Reading Processes in Irish-English Bilinguals: Evidence from the Stroop Interference Effect

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Introduction

One of the most obvious difficulties facing the beginner reader in the Irish context is encountering two apparently similar languages, Irish and English, within a relatively short time frame. While the Irish and English written languages are superficially similar, they hold conflicting rules that convert orthography (written forms) to phonology (sound forms). Interlexical homographs (words which share spelling but have different pronunciations and meanings in two languages) illustrate this point; written words such as *teach*, *bean*, and *fear* for example elicit different pronunciations and meanings in Irish and English. Many shared words and segments requiring different reading rules exist in these languages and require an early appreciation of multiple orthography-phonology correspondences. Conflicting correspondences are evident throughout the languages as there are few sound-spelling mappings that are shared by words in both languages. Furthermore, initial mutations in Irish require the reader to recognise words across orthographic variations (and phonological variations in speech). The two major classes of initial mutation are lenition (the *séimhiú*) and eclipsis (*urú*). The former typically involves conversion to a fricative and is written by an additional ‘h’ after the consonant, a convention that replaced the use of a diacritic. Eclipsis involves voicing of voiceless stops, nasalisation of voiced stops and prefixing of ‘n’ to vowel-initial words and takes a variety of forms, depending on the concomitant consonant. There are also t- and h- protheses on vowel-initial words. These mutations require the reader to recognise words across changes in pronunciation and mutated spelling. For example, the word for boat, *bád* is eclipsed in *i mbád* and aspirated in *trí bhád*, the root /b/ sound replaced by /m/ and /v/ respectively.

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The Irish written language has a relatively predictable orthography, in that much sound information is provided for reading (spelling may be more ambiguous). The use of a diacritic (*síneadh fada*) over vowels to indicate length and the additional distinction between consonants that are slender (*caol*) or broad (*leathan*) further aids pronunciation (for example *bád* with a broad d means a boat while *báid* with a slender d means boats; the 'á' signals a long vowel a).

By contrast, in written English the relationship between orthography and phonology is inconsistent for both sound-spelling and writing-sound relationships. For example, the sound /ai/ can be written as in 'mine', 'pie' or 'my' and the grapheme 'a' pronounced as in /fate/, /fat/ and /father/. There are also peculiarities of spelling, with regular patterns, as in 'hint', 'rave' and 'leak' confounded by irregulars like 'pint', 'have' and 'steak'. There are highly unusual representations, often derived from imported words, such as 'yacht', 'island' and 'ghost' (examples from Harley, 1995). Furthermore, the English lexicon includes homographs (spellings that elicit several pronunciations and meanings, e.g. 'bow', 'row' and 'tear') and homophones (different spellings for the same sound, such as right/ rite/ write). Such patterns mean that many words cannot be read using a 'sounding-out' strategy only. The problems presented for the developing reader are not as evident in other, more transparent, languages, such as Serbo-Croatian and Italian, and contrast markedly with patterns of reading development in non-alphabetic script languages, such as those employing a syllabic, consonantal or logographic-morphemic script. (The interested reader is referred to Harris and Hatano (1999) for a comprehensive treatment of these issues.) The orthography has further implications for bilingual readers, who must accommodate another, perhaps incompatible, set of correspondences from their other language. Taking the Irish-English example, the superficial similarities in script may present further challenges.

One way in which the relationship between bilinguals' orthographies has been studied involves the use of the Stroop interference effect (Stroop, 1935). The classic Stroop colour-naming task requires the subject in an experiment to name the colour in which a word is printed when the word is itself a colour term. When the word meaning is congruent with the colour of the print (e.g. the word 'red' printed in red ink), response times are faster than both the incongruent counterpart (e.g. the word 'blue' written in red ink, requiring the response 'red') and pure colour naming. The Stroop task has been used to study automaticity of reading processes and attentional

control as well as the relationship between languages in bi-/multilinguals (see MacLeod, 1991, for an overview). While explanations of the effect continue to be debated, one account of Stroop interference proposes that it reflects the competition of two responses, where faster word reading interferes with slower colour naming. The speed of reading reflects its automaticity in skilled readers, ensuring that the read word activates meaning quickly, interfering with colour naming when the stimuli are incongruent. The emergence of the effect in early childhood may reflect increasing automaticity as reading competence improves (e.g. West & Stanovich, 1978). This has led to considerable interest in the relationship between Stroop interference and reading skill in beginner and competent readers.

The bilingual Stroop task involves the presentation of stimuli in two languages, with subjects required to respond in both languages across a series of word-colour congruent and incongruent conditions. The effect is more controllable in a bilingual's dominant language (Tzelgov *et al.*, 1990; Altarriba and Mathis, 1997) and is more pronounced within languages (MacLeod, 1991). Intralingual interference is demonstrated when the language of the written words is also the language of response. Interlingual interference occurs when the language of the written words and that of response differ. Interlingual interference has been found to emerge robustly across a range of language combinations (see MacLeod, 1991; Preston and Lambert, 1969; Dyer, 1971) and is generally greater from the dominant (L1) language (MacLeod, 1991). This assumes that the dominant spoken language is also dominant for reading. A study by Gerhand *et al.* (1995) found intralingual interference for Scots Gaelic (L1) and English, with interlingual interference demonstrated only for English words with Gaelic responses. This was interpreted as reflecting the dominance of the English written language (in that it was more automatic) in these Gaelic L1 speakers. The precise effects have been shown to vary with language similarity (e.g., Fang *et al.*, 1981; Biederman and Tsao, 1979), and dominance of the response language/relative proficiency (e.g., Mägiste, 1985).

The Stroop effect should emerge only with automaticity of word recognition, as it is the automatic triggering of meaning that generates interference in the incongruent Stroop condition. If the conceptual links between two languages have not yet formed (as in novice bilinguals e.g., see Mägiste, 1985), the interlanguage Stroop effect should not emerge (particularly from the non-dominant language). Analysis of the precise

patterns of interference may therefore prove informative with respect to the degree of automaticity and the relative status of reading in each language as well as issues of lexical relationships between them. To this end, the following provides an overview of some Stroop interference data from Irish-English bilinguals, with contrasting levels of Irish-English language competence.

General Method

The same general method was followed for the two experiments described. Bilingual adult students completed a series of Stroop and colour naming conditions. Four Stroop conditions presented Irish or English words for congruent and incongruent conditions, as illustrated for one colour response in Table 1. Rapid colour naming was also completed. Subjects responded in Irish or English.

TABLE 1 EXAMPLE OF STROOP CONDITIONS LEADING TO THE RESPONSE 'RED'

Language of task	Congruent		Incongruent		Response
	Word	Colour of print	Word	Colour of print	
English	Red	Red	Blue	Red	Red
English	Red	Red	Blue	Red	Dearg
Irish	Dearg	Red	Gorm	Red	Red
Irish	Dearg	Red	Gorm	Red	Dearg

Stimuli were presented on white A4 card, with fifty items for each task. The selected colour words were chosen so that they required similar length responses in each language. The colour terms used were: white/bán, black/dubh, red/dearg, green/glas and blue/gorm. Order of items was randomised across test cards. Subjects were instructed to respond in Irish or English for each of the tasks. A rapid colour naming task was administered first yielding baseline colour naming times. The Stroop tasks were then presented, with order counterbalanced over subjects. Subjects were timed as they named the colours aloud, from left to right row by row for each task card. Timing commenced with a signal to start and stopped on the last item. Data refer to response time (RT) in seconds for a fifty-item task.

Experiment 1

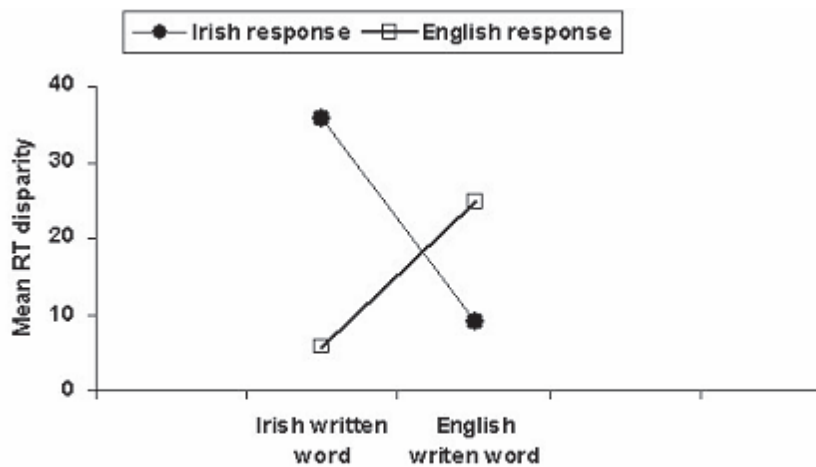
In the first study, English L1, competent Irish speakers ($n=50$) were selected for participation based on reported use of Irish, Leaving Certificate performance and performance on a pre-test. Average age was 21 years (male:female = 1:3); all were third level students. Little difference was observed between basic reading speed in Irish and English, as derived from the word-colour congruent tasks. Colour naming was significantly faster in English ($t(48)=5.46, p=.01$). On the Stroop tasks, overall response times were significantly slower in Irish ($F(1,48)=11.1, p=.01$), while Irish language tasks generated faster responses than the English tasks ($F(1,48)=10.35, p=.01$), reflecting poor performance for Irish responses on the English task. As might be expected the incongruent conditions generated slower RTs than the congruent, particularly affecting responses in Irish. There was no significant difference due to response language on the English incongruent condition, suggesting the relative disadvantage of responding in English for this task. Basic interference scores were derived as the RTs for incongruent minus congruent conditions across the two languages of stimulus and response. The interference scores thus take account of relative differences in responding and can be compared across the two experiments. Figure 1 graphs the data for Experiment 1.

Figure 1 shows that the condition that produces the greatest interference score, that is the greatest RT difference between performance on the congruent and incongruent conditions, is where Irish written words require Irish responses (i.e., *DEARG* written in red, as against *GORM* written in red, where the response is the colour term in Irish i.e., '*dearg*'). A large disparity is also apparent for English written words requiring English responses. These two conditions represent interference within a language or intralingual interference and the differential reflects the relatively fast responses on the congruent conditions. Far less interference is apparent in the two cross-language conditions, that is Irish written words requiring responses in English and English written words requiring responses in Irish. Here the congruent conditions involve a translation effect; e.g., for RED written in red ink, respond '*dearg*'. The relative difficulty already inherent in this task (even when congruent) means that there is a relatively less detrimental increase in difficulty for the congruent version of this task, e.g., RED written in blue, respond '*gorm*'.

The strongest interference comes from within-language conditions. The intralingual interference particularly affects the Irish conditions, showing a starker disadvantage for responding in Irish for incongruent

Irish stimuli. The intralingual effect is stronger than that of interlingual interference, with Irish responses showing more interference for both in Experiment 1. A modest but significant interlingual effect is evident for both languages, and is again stronger for responses made in Irish on the English task, i.e. interference from the dominant language.

FIGURE 1: INTERFERENCE SCORES FOR STROOP CONDITIONS: EXPERIMENT 1



Experiment 2

In Experiment 2, 60 fluent Irish speakers (average age 20 years, male:female = 5:7) participated. One third were L1 Irish speakers, half had an L1-Irish parent, and all completed Irish at Honours level in the Leaving Certificate (with a third achieving A grades). 51 of the 60 were studying Irish at third level. This group therefore represents a sample of fluent Irish speakers and readers.

Basic colour naming was significantly faster for English responses ($t(58)=6.5$, $p=.01$), though the mean difference is smaller than that observed in Experiment 1. Again reading speeds in the two languages were comparable, with faster overall performance than seen in Experiment 1, particularly with regard to Irish responses.

Across the Stroop conditions, responses were faster in English ($F(1,58)=20.4$, $p=.01$), while responses were similar for English and Irish written words overall. Again the incongruent conditions generated slower

RTs than the congruent, particularly affecting responses in Irish. There was no significant difference due to response language on the English incongruent condition, again suggesting the relative disadvantage of responding in English for this task.

Figure 2 graphs the interference scores for Experiment 2. The pattern of intralingual interference is similar to that seen in Experiment 1, with slower Irish responses to Irish written words. However the interlingual effect is reversed in Experiment 2. Here Irish responses to the English written words show less interference than English responses to the Irish words; interference is stronger from the Irish written language.

FIGURE 2: INTERFERENCE SCORES FOR STROOP CONDITIONS: EXPERIMENT 2

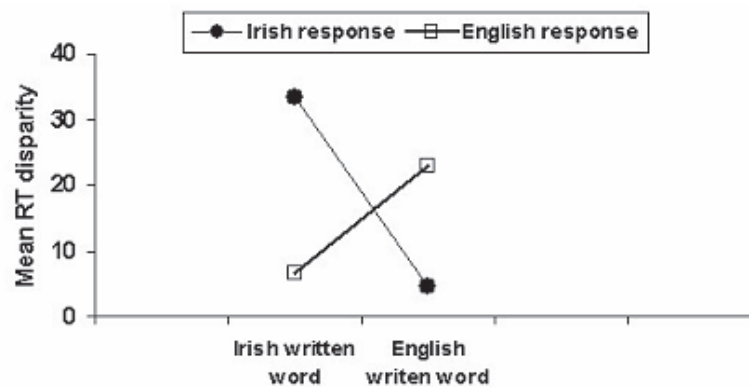
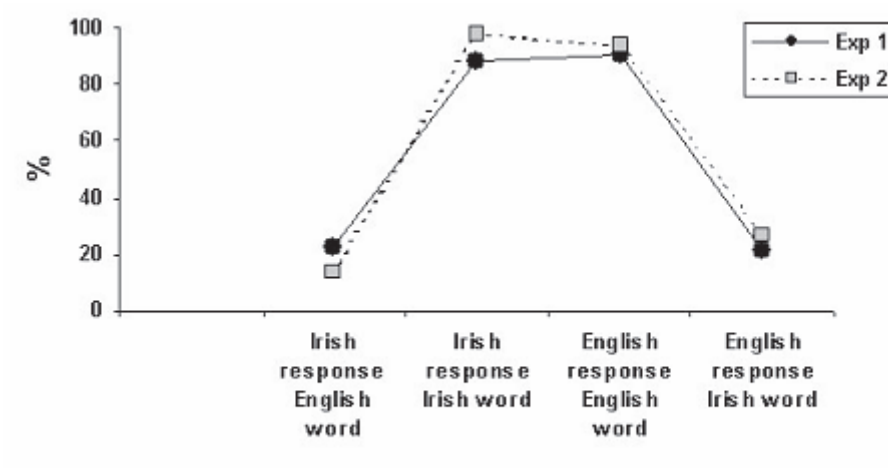


Figure 3 graphs interference scores for the two groups taking into account the differences in pure colour naming for the two languages and for the two language groups. From the left of the Figure, differences can be seen on the first two Stroop conditions. For Irish responses to English words, the more fluent (Experiment 2) group can be seen to have encountered less interference from the English word. The second data points represent interference for Irish responses to Irish words. Here the Experiment 2 subjects can be seen to be at more of a disadvantage, even taking into account their faster colour naming times. They show more intralingual interference within the Irish language than the Experiment 1 group, although both groups show a stronger intralingual effect for Irish relative to English. These differences are statistically significant.

FIGURE 3: INTERFERENCE CONTROLLING FOR COLOUR NAMING RT DIFFERENCES



Thus when responding in English the two groups behave comparably but differences emerge when examining performances that require responses to be made in Irish. For both groups however intralingual interference is by far the stronger effect.

Conclusions

This study has demonstrated typical Stroop interference both within and between languages for Irish-English bilinguals. Reading Irish stimuli shows automaticity for both groups; interlingual interference is evident when English responses were made on the Irish, incongruent task relative to the Irish, congruent task (e.g., where *dearg* was written in blue ink, or 'gorm' was written in blue ink, requiring the response blue). In Experiment 1, the interlingual effect was stronger again for responses made in Irish on the English task, i.e. from the dominant language. In Experiment 2, the interlingual effect was stronger for English responses given Irish written words. The interlingual effect was more modest than that generally reported, however (see MacLeod, 1991), perhaps suggesting less interaction between the two languages than generally observed for balanced bilinguals.

In line with the wider literature on the bilingual Stroop, stronger intralingual interference was apparent. For both groups overall response

times and interference scores were greater for the Irish language, despite similar base reading rates for the two languages. This may reflect poorer attentional control for that language. Further research is required to pull apart the effect of reading automaticity from that of attentional control.

These findings compare to those of Gerhand *et al.* (1995) who found intralingual interference in English and Scots Gaelic, but interlingual interference only for Gaelic responses to English stimuli. This pattern in Gaelic L1 bilinguals was interpreted as resulting from the superior automaticity of English written words, as this subject group had far less experience of their native language when it came to the written form. In the current study, the fluent speakers in Experiment 2 would have had substantial exposure to written as well as oral Irish, which may underlie the effect seen here.

Interpretation of these data must consider the characteristics of this subject group. All subjects were in third level education and thus even the less fluent group would have had good written Irish skills. An effect of disparity between oral and written skills similar to that reported by Gerhand *et al.* (1995) might be more apparent in a more typical sample of L1 Irish speakers. Such studies therefore need to consider not just spoken ability but language ability across a range of tasks.

While there was a substantial sex bias in the sample, no sex difference was observed on any of the measures here and differences are not generally apparent in Stroop studies that have considered individual differences (e.g. Golden, 1974; MacLeod, 1991). This bias derived from the study's inclusion criteria; more females than males were eligible for participation based on the criteria detailed above. This reflects Leaving Certificate trends; according to a report for the National Council for Curriculum and Assessment (Elwood, 2002), 65.6% of those taking the Higher Level Leaving Certificate in Irish in 2001 were female and 82% of females achieved honours grades, compared to 74% of male candidates. Interestingly, individual differences in response times apparent in this study were predicted by Leaving Certificate performance, with speed of Irish responses overall positively associated with Leaving Certificate grade.

References

- Altarriba, J. & Mathis, K.M. (1997). Conceptual and lexical development in second language acquisition. *Journal of Memory and Language*, 36, 550-568.

- Biederman, I. & Tsao, Y.C. (1979). On processing Chinese ideographs and English words: Some implications from Stroop-test results. *Cognitive Psychology*, *11*, 125-132.
- Dyer, F.N. (1971). Colour-naming interference in monolinguals and bilinguals. *Journal of Verbal Learning and Verbal Behavior*, *10*, 297-302.
- Elwood, J. (2002). *Differential performance by gender and achievement in the Certificate Examination Results 2000/2001: Initial findings from the research*. Dublin: National Council for Curriculum and Assessment.
- Fang, S.P., Tzeng, O.J. & Alva, L. (1981). Intralanguage vs. interlanguage Stroop effects in two types of writing system. *Memory and Cognition*, *9*, 609-617.
- Gerhand, S.J., Deregowski, J.B. & McAllister, H. (1995). Stroop phenomenon as a measure of cognitive functioning in bilingual (Gaelic/English) subjects. *British Journal of Psychology*, *86*, 89-92.
- Golden, C.J. (1974). Sex differences in performance on the Stroop Color and Word Test. *Perceptual and Motor Skills*, *39*, 1067-1070.
- Harley, T. (1995). *The Psychology of Language*. Hove: Erlbaum.
- Harris, M. & Hatano, G. (1999). *Learning to read and write: A cross-linguistic perspective*. Cambridge: Cambridge University Press.
- MacLeod, C.M. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin*, *109*, 163-203.
- Mägiste, E. (1985). Stroop tasks and dichotic translation: The development of interference patterns in bilinguals. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *10*, 304-315.
- Preston, M.S. & Lambert, W.E. (1969). Interlingual interference in a bilingual version of the Stroop color-word task. *Journal of Verbal Learning and Verbal Behavior*, *8*, 295-301.
- Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*, 643-662.
- Tzelgov, J., Henik, A. & Leiser, D. (1990). Controlling Stroop interference: Evidence from a bilingual task. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *16*, 760-771.
- West, R.F. & Stanovich, K.E. (1978). Automatic contextual facilitation in readers of three ages. *Child Development*, *49*, 717-727.