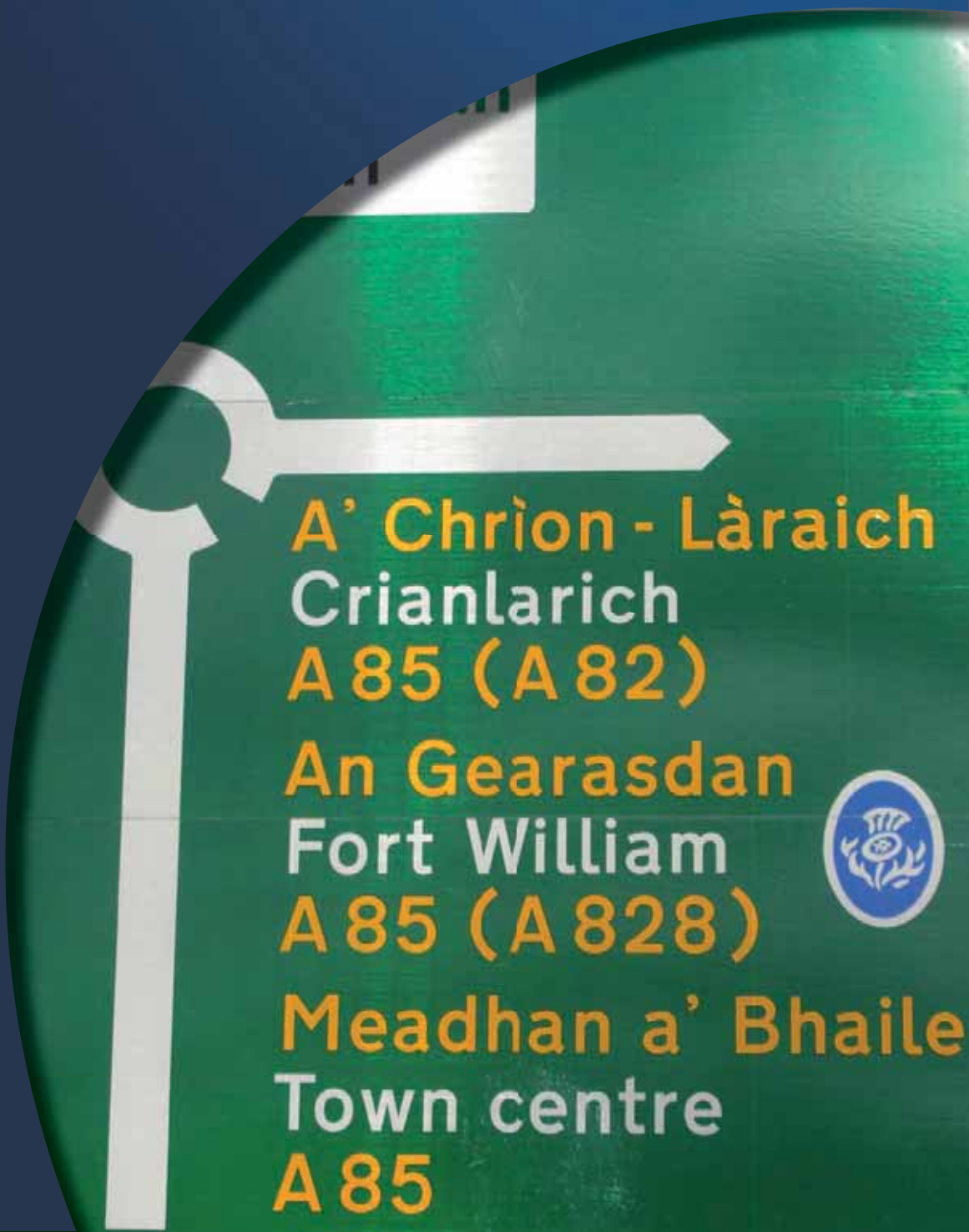
Published Project Report
PPR589

Creating the future of transport

Analyses of the effects of bilingual signs on road safety in Scotland – final report

N Kinnear, S Helman, S Buttress, L Smith, E Delmonte, L Lloyd and B Sexton



Transport Research Laboratory

PROJECT REPORT PPR589

Analyses of the effects of bilingual signs on road safety in Scotland

by N Kinnear, S Helman, S Buttress, L Smith, E Delmonte, L Lloyd and B Sexton (TRL)

Client: **Transport Scotland,**
Neil Wands

	Name	Date Approved
Project Manager	Lorna Pearce	09/02/2012
Technical Referee	Shaun Helman	09/02/2012

When purchased in hard copy, this publication is printed on paper that is FSC (Forestry Stewardship Council) and TCF (Totally Chlorine Free) registered.

Contents Amendment Record

This report has been issued and amended as follows

Version	Date	Description	Editor	Technical Referee
1	12/11/2010	Draft report	NK	SH
2	26/01/2011	Draft report with minor amendments	NK	SH
3	23/11/11	Draft final report	LP	SH
4	09/02/12	Final report	NK	SH

Contents

List of Figures

List of Tables

Executive summary

Background

The Scottish Government's Gaelic Language Plan (2010), prepared within the framework of the Gaelic Language (Scotland) Act (2005), looks to enhance the status of Gaelic and encourage its use. The Scottish Government recognises the importance of creating opportunities for the practical use of Gaelic including its presence on signage.

As part of The Scottish Government's current bilingual signing strategy, bilingual road signs were installed on selected trunk roads in the West Highlands. TRL was commissioned by Transport Scotland to evaluate whether there was any evidence that the installation of bilingual signs in Scotland had any impact on road safety. To investigate the effect of the installation of bilingual signs within a constantly changing road safety context, a multiple methods approach was used:

- a review of international literature.
- analysis of Scottish accident data.
- attitudinal survey of drivers (to bilingual road signs).

In addition to these tasks, interviews with six local authorities in Scotland also took place as part of the research.

The results of each of these approaches was collated to develop a full picture of the impact of bilingual signs on road safety in Scotland. While each of these approaches is summarised individually, the findings have been considered holistically and interpreted within the context of existing literature.

The research was limited by several confounds and unknowns. In replacing monolingual road signs with bilingual signs, it is possible that sign size increased by up to 90%. Consequently, at some sites safety structures were upgraded at the time of installation, and as noted in the feasibility study, old signs were replaced with new. In addition, there may have been further safety improvements made to the roads, new speed limits set on sections of road, or other enforcement changes, during the time periods used for analysis in the current study. These factors were considered throughout the research, and every attempt made to control for them.

Review of international literature

The literature review established that there were very few scientific studies of bilingual or multilingual signs and road safety or driver behaviour. There was a clear gap in the international literature with very few countries having considered the safety impact of them. Communication with representatives from other countries found that most countries with bilingual or multilingual road signs had not evaluated their impact on road safety assuming it not to be a problem; however a couple of European countries had resisted their installation on the basis of safety fears. Either way, there were very few examples of evidence to support these views.

Some experimental research has taken place, including that undertaken in the UK based on Welsh and English bilingual signs. Much of this research has measured the time taken to read a sign as a proxy for safety impact, assuming that while drivers are looking away from the road, they are not attending to safety-critical stimuli. Of course this may only impact on safety in certain driving situations, as drivers may use several glances to read a sign rather than read the sign in a single glance. The research on reading times suggests that reading times increase in a linear fashion with each line of text added. Obviously bilingual signs require more lines of text, hence they will take longer to read. This is however related to the complexity of the sign rather than the bilingual nature of the content, although this too appears to increase reading times for drivers whose dominant language is not presented first; in Scotland Gaelic is presented above English.

A simulator study of Welsh and English bilingual Variable Message Signs found that in high workload conditions drivers were unable to maintain a safe distance to the car in front when trying to read four-line monolingual and bilingual signs. In addition, drivers appeared to suffer a 'hangover' period after passing a bilingual sign whereby their speed management suffered, with the authors suggesting that drivers were still trying to comprehend if they had missed some important information after passing the sign. This study, and other laboratory and track studies, suggest that there is evidence that bilingual signs may impact on driver behaviour due to increasing the demand of the driving task.

Complementary research in the fields of workload and distraction has established a link between these factors and accident risk.

Analysis of Scottish accident data

The aim of analysing Scottish accident data was to check for any change in trends of accident rates on bilingual signed routes that could be attributed to the installation of bilingual signs. To do this the analysis used before and after accident data for each route while also comparing data with carefully selected (comparable) routes in Scotland where no bilingual signs were installed.

Two types of analysis were used: one to analyse each route individually, and a second to test for any overall change in accident rates.

- Firstly, individual route analysis controlled for traffic flow on the bilingual and comparison routes and found no significant effects for Killed and Serious Injury (KSI) accidents suggesting that the pattern of accident trends on bilingual signed routes was no different to the general trends on other roads in Scotland. There was no information available regarding other changes on the routes that may have occurred concurrently with the bilingual sign installation (e.g. other road safety engineering, or enforcement). Overall the individual route analysis did not provide any compelling evidence that the installation of bilingual signs has led to either an overall safety benefit, or an overall safety disbenefit.
- The second analysis used a general linear model to explain the number of accidents per month taking into account the exposure, trend and seasonal effects based on the comparison route data and the bilingual sign route data prior to the installation of bilingual signs. Looking at all routes combined, the model found no significant changes, suggesting that the overall accident rates before and after installation of the signs were similar to what would have been expected had the signs not been installed.

Several assumptions had to be made for both analyses including the assumption that comparison routes were directly comparable to the bilingual signed routes.

Attitudinal survey of drivers

Researchers visited seven sites along the trunk route corridor where bilingual signs had been installed to collect data from drivers who were divided into three groups: local drivers who could read Gaelic; local drivers who could not read Gaelic; and tourists. These groups will be referred to as 'Gaelic', 'Non-Gaelic' and 'Tourist' when describing the results.

For the survey questionnaire, five pictures of bilingual road signs taken on site visits were selected (consisting of four advanced directional signs and one route confirmatory sign). To enable direct comparison of monolingual and bilingual road signs, copies of the bilingual signs were digitally altered to represent their monolingual equivalents.

The attitudinal survey was designed to:

- distinguish any difference between participants' self-reported behaviour and attitudes towards monolingual and bilingual road signs;

- establish general attitudes to road signs and bilingual road signs; and
- establish if drivers report any impact on road safety due to bilingual road signs.

The survey results indicated that all groups found it more difficult to locate information on bilingual signs than on monolingual signs. While a clear majority of respondents in the Non-Gaelic and Tourist groups found it easier to locate information on monolingual signs compared to bilingual signs, the difference was not as great for the Gaelic group. Although the Gaelic group still found it easier to locate information on the monolingual signs, a sizeable proportion of this group reported no difference between the signs.

A similar result was found in relation to the attractiveness of the scene when comparing pictures of monolingual and bilingual signs. Both the Non-Gaelic and Tourist groups thought the monolingual sign scenes were more attractive than the bilingual sign scenes, while the Gaelic group reported neither to be more or less attractive than the other.

Interestingly, all groups reported that they would drive at slower speeds in the scenes showing bilingual signs when compared with the equivalent monolingual sign scene for at least two of the four sets of pictures presented; Tourists reported slower speeds for all sets of pictures.

Drivers were also asked to indicate if they had experienced any of the situations described in a set of seven statements. Analysis of these self-reported behaviours found that all driver groups reported finding it more difficult to locate information on bilingual signs compared to monolingual signs, and also that they were more likely to have had to stop to read bilingual signs compared to monolingual signs.

While the Gaelic group did not report any further behaviours specific to the different signs, both the Non-Gaelic and Tourist groups reported having had to slow down for bilingual signs, having taken a wrong turn because of bilingual signs, and having been distracted because of bilingual signs.

Interviews with local authorities

Face to face unstructured interviews took place between the researchers and six local authorities in Scotland that were identified by Transport Scotland. The local authorities represented a mix of those with and without strong Gaelic heritage. The aim of the interviews was to obtain their perceptions of the impact of bilingual signs on road safety and what, if any, evidence they were using to form that opinion. It was also important to understand their overall views towards bilingual signs and the possibility of installing them in their area if they did not already have any.

The local authorities' opinions towards bilingual signs were generally dependent on the Gaelic heritage within their region and how much they were currently actively promoting Gaelic (e.g. in schools). Local authorities reported that their main areas of concern involved: relevance in their area, the logistical and financial impact of installing new signs, the impact on tourists, and road safety; most assumed road safety was not a problem although they had no evidence to support that view.

Discussion

The results of the research have been considered holistically and within the context of driver behaviour literature so as to fully understand the effect that bilingual signs have had on road safety in Scotland. In interpreting the results, the confounding and unknown variables that limit this work have been noted, as outlined in the Background.

The results have been interpreted within the context of Fuller's (2005) Task Capability Interface model of driver behaviour and the theory of Risk Allostasis (Fuller, 2008). The model proposes that driving involves the real-time maintenance of the gap between the demand of the task (Task Demand) and the capability of the driver (Capability). When Task Demand exceeds Capability a loss of control will occur and result in either a lucky escape or a collision. The gap between Task Demand and Capability is a driver's safety

margin, otherwise termed as their margin for error or comfort zone. It is proposed that most of the time, drivers like to keep within a safety margin that feels comfortable and therefore drivers manipulate Task Demand by slowing down or speeding up, depending on the state of many other factors in the environment (e.g. other road users, lane width, road geometry, lighting, etc.). This process of manipulation by the driver is called the theory of Risk Allostasis.

Evidence from the literature review suggests that more complex signs take longer to read and can affect driver behaviour in high workload situations. In terms of the model, this implies that bilingual signs, by virtue of being more complex and including two languages, will raise Task Demand. In line with the theory of Risk Allostasis, drivers in the survey, and in a previous simulator study, are found to reduce speed in response to signs of increased complexity. The survey data from this study provide further support that bilingual signs increase Task Demand as all driver groups reported that finding information on monolingual signs was easier than finding information on bilingual signs.

The accident analysis did not find evidence that the installation of bilingual signs has resulted in an increase or decrease in accident rates. It is therefore possible that the increase in task demand associated with bilingual signs is small enough to be absorbed into drivers' safety margins and where it increases task demand significantly, drivers will slow down to maintain their original safety margin. These responses would negate the increase in Task Demand. An area of caution involves tourists driving in Scotland, due to an already high Task Demand resulting from driving on unfamiliar roads.

Conclusion

It is concluded that while there is evidence that bilingual signs may have increased the demand of the driving task, this increase can be absorbed, and managed, by the driver and therefore does not result in a significant increase in crash risk and accident involvement.

Analysis of accident data in Scotland concurred with this conclusion, finding no evidence that accidents increased or decreased as a result of bilingual sign installation.

Abstract

Bilingual signs were installed on selected trunk roads in Scotland following a feasibility study in 2002. Since the introduction of the signs, there has been no evaluation of what impact the signs may have had on driver behaviour, attitudes or accident rates. Transport Scotland commissioned TRL to lead a project investigating whether there is evidence that bilingual signs have had any effect on road safety and to establish the public's attitudes towards the signs. The main report presents the results of the project, which used three sources of evidence to establish the likely effect of the signs on driver behaviour and attitudes in relation to road safety. Results of a review of international literature, analysis of accident data and a survey of 440 drivers are considered in the context of the Task Capability Interface model (Fuller, 2005) of driver behaviour. The report suggests that while there is reasonable evidence to infer bilingual signs increase the demand of the driving task, drivers appear able to absorb this extra demand, or negate it by slowing down, which ultimately results in no detectable change in accident rates.

1 Introduction

1.1 Background

Bilingual Gaelic and English language road signs replaced monolingual (English only) road signs on selected trunk roads in the West Highlands of Scotland following a feasibility study in 2002 (Scottish Executive, 2002). These bilingual road signs have been present on designated trunk roads since 2004 with almost all planned routes having had bilingual signs installed.

The Scottish Government is committed to securing Gaelic as an integral part of Scotland's heritage, national identity and cultural life. The Gaelic Language Plan (2010) outlines the steps that the Scottish Government has taken, and aims to take, to raise the profile of the Gaelic language. The plan includes ways to enhance the status of the Gaelic language, promote its acquisition and learning, and encourage its use. The presence of Gaelic on road signs in areas where a large proportion of Gaelic users reside supports this aim.

Replacement of monolingual road signs with bilingual road signs results in a number of practical changes that can alter the context for road users. Such changes to Scotland's trunk road network require evaluation in light of Scotland's Road Safety Framework to 2020.

When monolingual road signs are replaced with bilingual road signs, it results in a number of practical changes that can impact on the road user. Such changes include obvious modifications in the amount of text and the impact of displaying two languages. Other changes include indirect consequences of adding the text; for example, sign size can increase by as much as 90%[1] to accommodate the extra text. It is reasonable to consider that a change from monolingual to bilingual road signs, either by virtue of the extra text on the sign, or through the increased size of the signs, might affect driver perception, behaviour and safety when previous research evidence is considered. Early laboratory and track tests carried out at TRL prior to the installation of bilingual road signs in Wales found that in comparison to equivalent monolingual road signs, bilingual road signs took drivers 15–40% longer to read (Rutley, 1972). More recently, simulator tests found evidence to suggest that bilingual road signs increased driver workload (Jamson, Tate & Jamson, 2005). However, it is also reported that drivers compensate by reducing their speed to read more complex signs; of course, reduced speeds could lead to safety benefits. The effect of the installation of bilingual signs could therefore theoretically have both a positive and negative effect on road safety, however, very little is understood about how these mechanisms may ultimately impact on accident rate. It is evident that the effect of installing bilingual signs on trunk roads in Scotland on driver behaviour and road safety is not understood.

TRL was commissioned by Transport Scotland to investigate if there is evidence that the installation of bilingual road signs has had any impact on road safety. TRL proposed that given the potentially subtle nature of any effects, it was necessary to adopt a multi-disciplinary approach. TRL therefore proposed carrying out three main tasks:

1. **A review of literature** pertinent to bilingual signs and of other countries' experiences with bilingual signs to determine whether any lessons can be learned.
2. **Analysis of accident data** on routes that have had bilingual signs installed. The accident data allows for quantification of any effect on accident rates resulting from the installation of bilingual signs.

[1] The actual increase in sign size will vary depending on the unique characteristics of each sign depending on the sign type and the amount of text required.

3. **Attitudinal surveys of drivers** using questionnaires. This task allows for a measurement of self-reported perceptions and opinions of bilingual signs, as well as self-reported behaviours.

It should be noted that a multi-method approach is crucial, since all of these methods in isolation have strengths and weaknesses. These are summarised in Table 1.1.

Table 1.1: Strengths and weaknesses of the different research methods

Method	Strengths	Potential weaknesses
Literature review	Published scientific papers can give rigorous data to answer specific questions (such as the effects of extra text on reading times). These findings can be extrapolated to novel situations if there are plausible psychological mechanisms that explain them.	International and academic literature is likely to be removed from the applied Scottish road context, and so may miss some aspects of this (for example, greater exposure of Scottish drivers to rural roads than is usual in other countries).
Analysis of accident data before and after installation of signs	Where data are available over long time-frames before and after the installation of signs, analysis should reveal any large-scale changes in the numbers (or rate) of accidents.	Long time-periods are usually needed to permit meaningful comparisons. Exposure (traffic flow) also needs to be taken into account if meaningful comparisons are to be drawn between different time periods and/or different routes. Also see Section 1.3 for specific limitations.
Attitudinal surveys	Data are easier to gather over short time-frames than accident data. Useful when the research is focused on uncovering differences between groups of drivers.	Data can be biased and responses are open to 'demand characteristics' where respondents give the answers they think the researchers might seek. Also see Section 1.3 for specific limitations.

By including multiple methods and drawing conclusions from the findings as a whole rather than any single finding using a single approach, it is more likely that the strengths of some methods will help to overcome the weaknesses of others.

This report presents the findings of these three tasks. The report also reports on stakeholder consultation in the form of interviews with staff from selected local authorities in Scotland.

1.2 Aim

The purpose of this project is to research the potential link between the installation of bilingual road signs on trunk roads in Scotland, and road safety. In addition, the

research was designed with the aim of understanding the public's attitude to bilingual road signs in terms of their safety, ease of use, and aesthetic impact.

1.3 Limitations

There are a number of limitations specific to the analysis of accident data and the attitudinal surveys. These limitations are related to the lack of additional information on other factors that may have changed concurrently as a result of replacing monolingual road signs with bilingual road signs.

Specific to the survey, the addition of Gaelic place names and an increase in sign size are the most obvious factors that change between the two conditions. Due to time restrictions, it was not possible to separate these factors. This means that the size of the sign is a confounding factor when asking people questions about monolingual and bilingual signs.

With respect to the accident analyses, there may be other changes at the time of sign replacement that are important to recognise. For example in replacing old signs with new ones, faded and worn signs will have been replaced with new, brighter and cleaner signs; importantly this includes the reflective materials that improve sign conspicuity, particularly at night. Further, site visits confirmed that safety structures at many sign sites were upgraded at the time of the bilingual sign being installed. While these factors have been considered throughout the research, and every attempt made to control for them (and other road safety improvements on these roads), where any effect on road safety is found it is not possible to determine the precise causal factor or mechanism of that effect (i.e. whether the addition of Gaelic place names has influenced road safety or whether sign size, sign conspicuity or sign safety structures have influenced road safety).

2 Methodology

2.1 Literature review

A full literature review was delivered to Transport Scotland in February 2009. The literature review set out to explore the topic, detailing relevant scientific research where possible, and to establish whether anything could be learned from other countries that use bilingual signs.

There are very few quality scientific studies of bilingual signs in relation to road safety. Much of the information related to bilingual signs is in the form of 'grey' literature (i.e. literature not published through conventional or peer-reviewed channels) and few studies consider the road safety impact of installing bilingual road signs. An extensive internet search was undertaken along with a key-word search through the TRL Library and Knowledge Base system.

The TRL Library has collections of published materials spanning the last 60 years in the form of books, periodicals, conference proceedings, standards, statistics, guidance notes and several thousand TRL Research Reports. The TRL Knowledge Base comprises a number of databases, including the Transport Research Abstracting and Cataloguing System (TRACS). This is the main catalogue of transport research publications held both in the TRL library and elsewhere. It contains bibliographic references and abstracts of English and foreign language articles from journals, books and research reports. It is the English language version of the worldwide ITRD (International Transport Research Documentation database) and contains abstracts from publications in the USA, Australia, Scandinavia, the Netherlands and Canada, in addition to UK material. The database has been updated daily since 1972 and comprises over 260,000 items.

Chapter 3 presents a summary of the literature review with updates from new literature where found.

2.2 Analysis of accident data

An analysis of accident data was carried out to quantify any road safety impact that the installation of bilingual signs may have had on the number of reported accidents. This analysis compared before and after accident data for the roads installed with bilingual signs and compared these data to equivalent roads in Scotland where no bilingual signs were installed. It also used modelling techniques to account for various confounding factors such as seasonality and background trend effects.

The detailed analysis of accident data is presented in Chapter 4.

2.3 Survey of drivers

Attitudinal surveys were undertaken to assess drivers' experiences of bilingual road signs in terms of their aesthetic impact and their impact on driver behaviour and road safety. Local drivers with and without Gaelic language ability were targeted, in addition to tourists, on the trunk road network where bilingual signs have been installed.

The surveys were designed so that responses to images from the drivers' perspective could be compared. The images used consisted of four directional signs and one route confirmatory sign that had been digitally edited to differ only in terms of the presence or absence of Gaelic text (and the extra size of the sign required to accommodate this text). For four of the signs, drivers rated the speed at which they would drive in each pictured scenario, the ease with which they could find information, and the impact of the sign on the attractiveness of the scene. In addition, drivers responded to a further picture by indicating whether signs such as those illustrated (both monolingual and bilingual versions of the sign were shown to respondents) had ever caused them to

experience situations that may impact on their driving behaviour (e.g. 'I have been distracted by signs like these').

The survey methodology and results of the survey are presented in Chapter 5.

2.4 Local authority interviews

Face to face interviews were carried out with representatives of six local authorities in Scotland. The main purpose of the interviews was to gain the views of key representatives from those local authorities that may have an interest in bilingual road signs.

The discussion was open, with topics allowed to flow without adhering to a structured interview schedule, although some prompts were used to aid dialogue.

The interviews with local authority representatives are reported in Chapter 6.

2.5 Discussion

It is important to consider the evidence presented in all chapters in its entirety before drawing conclusions. Chapter 7 discusses the key findings from the report in the context of relevant literature to understand the effect of bilingual road signs on driver behaviour and consequently on road safety.

3 Literature Review

3.1 Bilingual road signs in Scotland

Campaigns to incorporate the Gaelic language on Scottish road signs have been active for several decades. The foundations of such campaigns are rooted in the preservation and recognition of the Gaelic language and there is little evidence that road safety has been considered. The literature review established that in most countries that have taken decisions on whether bilingual or multilingual road signs should be used, road safety has not been considered and instead their introduction has been largely based on politically-motivated decision-making.

The first authorisation for bilingual road signs in Scotland was given for the A87 through Skye in 1984 followed by the western part of the A830 in 1996 (Moore, 2000). As there was no design specification the signage was inconsistent in style. Also in 1996, Highland Council adopted a 'Gaelic Signposting Policy' whereby bilingual place-names, and monolingual names which were deemed to be similar to the English version, were allowed for use on roads controlled by the council (Highland Council, 1996).

Highland Council also requested permission to erect Gaelic and English road signs on the A87 trunk road between Kyle of Lochalsh and Uig and on the A830 from Mallaig to Fort William (Moore, 2000). In October 1999, this was 'agreed in principle' by the Scottish Minister for Transport before being given the go-ahead in March 2001 once a design had been agreed.

Following on from the Highland Council's request, the Scottish Executive Development Department commissioned consultants Scott Wilson to undertake a study to investigate the feasibility of amending trunk road signing on a number of roads in the north west of Scotland to incorporate both Gaelic and English place names. The study suggested a five year replacement programme as shown in Figure 3.1[2]. It was estimated that the total cost would be approximately £3.1 million if existing x-height (character size) was retained and approximately £2.2 million if the x-height was reduced. The addition of Gaelic translations to the signs was found to increase the size of the sign by 90% if the original x-height was used or by 50% if a reduced x-height was used. The feasibility study did not attempt to measure any wider economic, social or cultural impact of installing bilingual road signs, however, it is mentioned that "…safety would not be much affected, but overall the impact should be beneficial" (Scottish Executive, 2002). The reason for stating that there may be a beneficial impact on road safety was due to the replacement of old signs with modern signs, rather than their bilingual nature. There was no consideration of drivers' interaction with the signs, including the bilingual text, in the feasibility study.

[2] Although bilingual road signs were installed on the roads depicted in the figure, the program of work did not follow the suggested timeline. The actual installation dates are reported in the accident analysis in section 4.

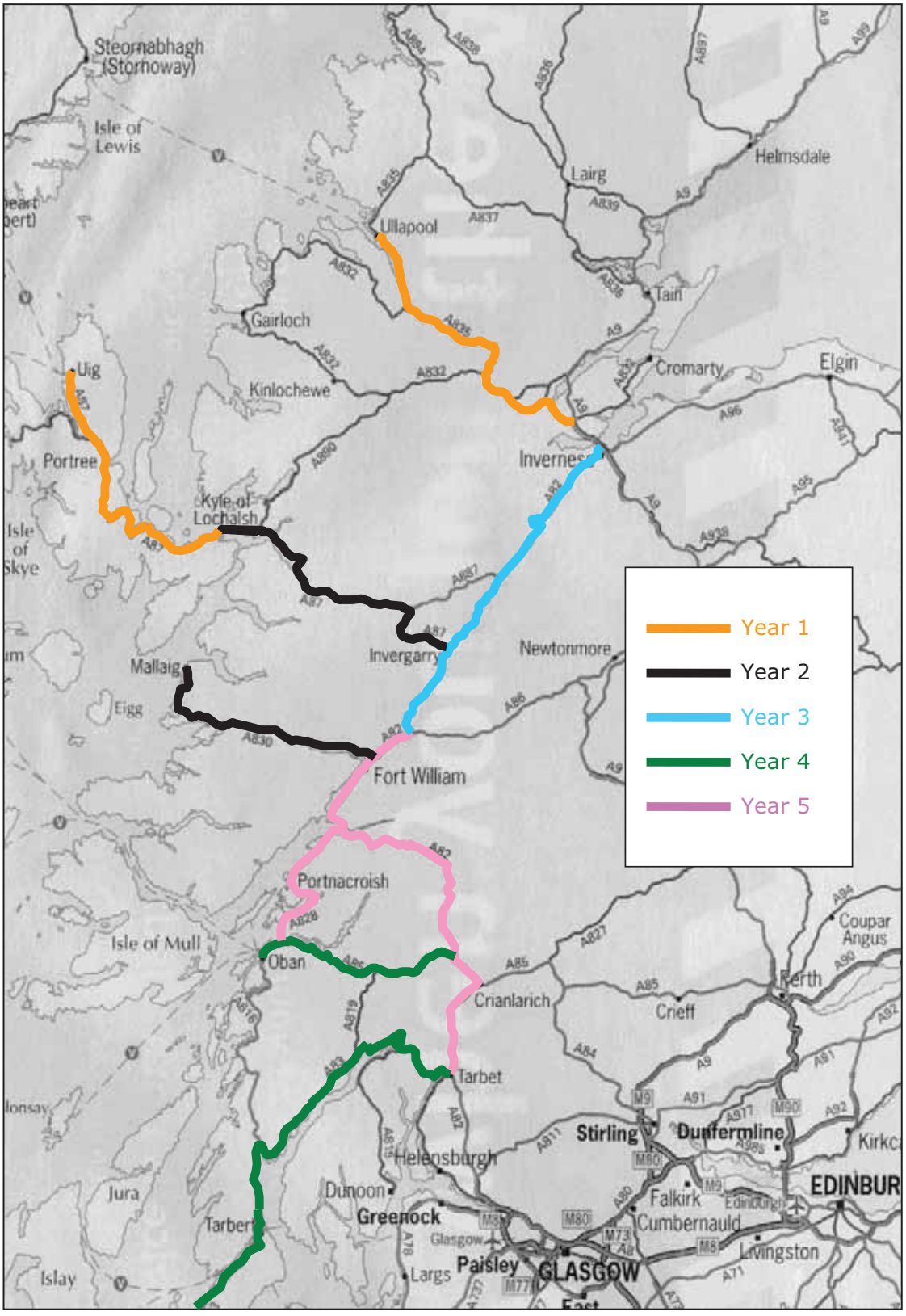


Figure 3.1: Five year plan for the installation of bilingual signs in Scotland as proposed in the feasibility study (Scottish Executive, 2002)

3.2 Driver information processing, behaviour and safety

Humans have a limited information processing capacity (see e.g. Wickens, 1984, and Baddeley & Hitch, 1974). Drivers must attend to driving-relevant stimuli in the environment while filtering out irrelevant stimuli, and they must ensure that they have enough of their mental resources left to maintain control of the vehicle while all this is happening. Anything that leads to a higher demand on the driver's limited mental resources can result in fewer resources being available for maintaining control of the vehicle, and for attending to safety-critical stimuli such as road hazards. Thus there is a plausible psychological mechanism by which more complex road signs might lead to extra demand on the mental resources of drivers, and thus may present a road safety risk.

3.2.1 Workload

Much work has been done to examine links between secondary tasks and accident risk while driving. Typically these studies have focused on mobile phone use, which can be conceptualised as having a workload-increasing or distracting effect (see Section 3.2.2). For example Redelmeier and Tibshirani (1997) studied accident-involved drivers over a 14-month period, and examined their mobile phone call history. They found that the use of a mobile phone (hands-free or hand-held) increased the risk of an accident four-fold. Other studies into the use of mobile phones (even hands-free) have shown similar increases in accident risk (e.g. Burns, Parkes, Burton, Smith & Burch, 2002). Such effects have also been seen in laboratory settings using tests of hazard perception skill (e.g. McKenna & Farrand, 1999); this is important as hazard perception skill has been shown to be linked to collision risk across a number of studies (Horswill & McKenna, 2004).

When a driver's workload becomes more than they can manage, this can be termed overload. Overload in terms of interaction with road signs has been defined as existing if a sign has more destinations on it than can be read in the time available (Agg, 1994). The time available to read a sign is dependent on factors such as the speed of the car, the size of the letters, the legibility of the sign and the position of the sign (Agg, 1994).

In a laboratory study of Variable Message Signs (VMS), Jamson (2004) tested monolingual and bilingual participants and asked them to recall monolingual and bilingual signs of varying length (to a maximum of four lines due to the restrictions of VMS) and complexity. The results suggested that drivers were able to read one- and two-line monolingual signs and two-line bilingual signs without interference to their task performance. However, a four-line bilingual sign took significantly longer to read than a four-line monolingual sign.

To test whether these laboratory findings would influence driver behaviour, Jamson *et al*. (2005) performed a simulator study. This research established that driver behaviour *was* influenced as drivers reduced their speed by up to 7mph approaching both the four-line monolingual and bilingual sign. A reduction in speed is commonly found in simulator and on-road studies when perceived workload increases (e.g. Lewis-Evans & Charlton, 2006; van Driel, Davidse & van Maarseveen, 2004; Smiley, 2000), and is consistent with Risk Allostasis (Fuller, 2008), a dominant theory of driver behaviour, whereby any increase in perceived task demand when driving is mediated by a reduction in speed so as to maintain a desired level of task demand[3]. As the participants in Jamson *et al.* (2005) reduced their speed to read both the four line monolingual and bilingual signs (but not the shorter signs) this suggests that the overall complexity of the sign impacted on their

[3] Risk Allostasis is one of a number of modern theories of driver behaviour. Alternatives include Vaa's (2007) 'monitor model' and Summala's (2007) 'comfort zone' model. All of these models share similar characteristics, for example they all include the role of feelings for detecting and initiating a behavioural response to risk. Fuller (2008) compares each model and seeks to integrate them on common grounds suggesting that while they differ in certain aspects of detail, there is in fact a convergence of theory that is self-supporting.

behaviour. However, there was evidence of an added influence of bilingual signs; while drivers returned to their previous speed after passing the four-line monolingual sign, there was no return to previous speed after passing the four-line bilingual sign. The authors suggested that drivers were still trying to process the information from the bilingual sign to work out whether they had missed any vital information, hence this detracted from the attention required for adequate speed regulation (Jamson *et al.*, 2005). It is possible, therefore, that the four-line bilingual sign caused overload or confusion which impacted on drivers' available attention for basic driving tasks. It is easy to ascribe some real-world relevance to this laboratory finding. If we assume that the laboratory task (driving simulation) is representative of the real driving task, then in the event of a concurrent change in circumstances in real driving (e.g. vehicle in front suddenly brakes), the driver may not have the available resources to deal with the situation safely if still experiencing increased workload[4].

In fact further evidence from Jamson *et al*.'s (2005) simulator study provides support for this theoretical driving scenario. Participants in the simulator study drove in low and high workload conditions whereby they had to follow a lead vehicle travelling at a set speed in the low workload condition, and follow a lead vehicle that varied its speed in the high workload condition. In the low workload condition, drivers' following distance increased when reading a four-line monolingual or bilingual sign; while in the high workload condition, drivers following distance decreased when reading the same signs. This suggests that drivers were either happy to accept a shorter following distance in the high workload condition or were unable to attend to both tasks at the same time and were temporarily unaware that they were closer to the vehicle in front.

3.2.2 Distraction

Put simply, anything has the potential to distract a driver (Basacik & Stevens, 2008). While driving a car, it is estimated that attention can be distracted to irrelevant objects and features near the roadway between 20% and 50% of the time (Green, 2002; Hughes & Cole, 1986; Land & Lee, 1994). Some of the most commonly cited distractions when driving include performing secondary tasks like speaking or texting on a mobile phone (Reed & Robbins, 2008), using in-car entertainment systems (Strayer, Drews & Johnston, 2003) and roadside advertising (Wallace, 2003)[5].

Driver distraction has been directly linked with road safety. For example, in the '100 car study', one hundred cars were fitted with discreet cameras and data recorders for a year, and it was found that almost 80% of all crashes and 65% of all near-crashes involved driver inattention (due to distraction, fatigue, or just looking away from the road) within three seconds prior to the crash or near-crash (Klauer, Dingus, Neale, Sudweeks & Ramsey, 2006). McEvoy, Stevenson and Woodward (2006) report that when drivers were asked to detail what distracted them prior to a recent crash, the main reasons that respondents stated were a lack of concentration, adjusting in-vehicle equipment, talking to passengers, and outside people, objects or events. In an earlier study, it was claimed that external distractions (people, objects or events) were the most frequently reported, accounting for almost 30% of distraction-related crashes (Stutts, Reinfurt, Staplin & Rodgman, 2001). Analysis of eye glance behaviour demonstrates that glances away from the road for more than two seconds significantly increase the risk of being involved in a crash or a near crash (Klauer *et al.*, 2006).

In Canada, Lesage (1981) tested drivers' perceptual processes when reading bilingual signs and concluded that it takes significantly longer to read a bilingual sign than a

[4] Of course, a reduction in speed may also have a road safety impact (a benefit). We return to this point in the discussion section of this report when discussing all of the evidence from the multiple methods used.

[5] Note that some of these examples, if not all of them, would be expected to have an impact on mental workload as well as having a basic distracting effect of pulling the driver's attention away from the driving task. It is outside of the scope of this paper to distinguish between the two mechanisms, beyond accepting that both probably have an effect on the available mental resources being devoted to driving the car and scanning the road ahead for potential hazards.

monolingual sign with the same number of lines. Further, it was reported that reading bilingual signs took longer for monolingual drivers than bilingual drivers. Jamson *et al.* (2005) similarly found complex signs to have a distracting influence on drivers. There was evidence from the study that drivers' ability to respond to instructions on the signs fell when faced with four lines compared to two lines, despite the fact that drivers had reduced their speed to read the four-line sign.

As part of an inquiry into the use of bilingual signs in Wales, Rutley (1972) performed experiments both in the laboratory and on a test track with 12 drivers who spoke English only, and six drivers who spoke both English and Welsh. It was reported that the drivers who could speak Welsh stated that they would usually read the English instructions on bilingual signs (Rutley, 1972). In the laboratory study participants took longer to read nearly all bilingual signs than the monolingual versions with simple crossroad signs taking 15% longer to read. When Welsh text was placed above English on these signs, the reading times increased to 30% longer. For listed five-destination directional signs, reading times increased by 28% in the laboratory. On the track, the bilingual directional signs took 15% longer to read, though this time the placement of Welsh above English saw an increase in reading time of 41%.

Hall, Mcdonald and Rutley (1991) and Jamson (2004) found that reading times increase in a linear manner with the number of names on a sign. The results of Jamson *et al*. (2005) and Rutley (1972) support this notion as they suggest that drivers will process all the information on a sign, not just the information they understand or necessarily require. Lesage (1978, 1981) found that as well as it taking longer to read a bilingual sign compared to a monolingual equivalent, this difference was greater for monolingual drivers than for bilingual drivers. If monolingual drivers were influenced only by the information they understand, then it should not take them any longer to read a bilingual sign. The data are consistent with the notion that monolingual drivers process all information on a bilingual sign at some level, and thus that multilingual information will result in all drivers having their eyes 'off the road' for longer.

Jamson (2004, p3) writes:

> "At any moment in time there will be many thousands of drivers on the road reading information from signs. For most there are no problems. It is the rare lapses in performance or recognition that impact on the safety and efficiency of the traffic system."

On the basis of the literature on distraction, some of it specific to the effects of bilingual signage, it is reasonable to conclude that there is potential for drivers to be distracted by bilingual or multilingual road signs and for this to impact on road safety.

3.3 Sign design

3.3.1 Language order

Rutley (1974) performed further experiments of Welsh and English bilingual road signs with the purpose of determining the effect on reading time of putting the Welsh or English place names first on signs. A similar experimental setup to that of the Rutley (1972) was used incorporating a laboratory and a track experiment. Overall, results supported those found by Rutley (1972), in that shorter reading times were established for signs with English above Welsh, and the more complex the signs the greater the effect of language order on reading time. Jamson (2004) also found that reading times were shorter when a person's preferred language was on top. The track study found the same effect of language order with the most complex sign (six destinations with Welsh above English) taking 37% longer to read than the equivalent sign with English above Welsh. Interestingly, when drivers who could speak Welsh were asked to read the Welsh names, reading times were shorter when Welsh was positioned above English. It would

therefore appear that language order is an important consideration for its effect on reading times dependent on a person's dominant language.

Language order is of particular interest in Scotland due to the decision to place Gaelic above English. It could be argued from the results of Rutley (1974) that drivers with no Gaelic language ability will spend longer reading these signs than if the signs had English above Gaelic. It was the conclusion of Baguley and Cooper's (2000) review of the effect of bilingual signs on road safety that bilingual road signs in Scotland should place English first. In practice, bilingual road signs introduced since 2003 in Scotland present Gaelic above English (as can be seen in Figure 3.2).

Figure 3.2: An example of a bilingual road sign in Scotland showing Gaelic presented above English

3.3.2 Language demarcation

Language demarcation refers to ways in which two or more languages can be presented on signs to improve processing time required to retrieve information from the sign (Jamson, 2004). Baines and Dixon (2003) argue that language demarcation is the central issue in bilingual sign design. They give the example of signs in Saudi Arabia where simply the visual difference between Latin and Arabic scripts is enough to differentiate the languages, whereas in countries where the languages have similar scripts, other styling is required.

Jamson (2004) indicates that there are essentially four ways in which language demarcation can be achieved on bilingual road signs:

1. **Colour**: Different colouration of languages can make them distinguishable where the colouring is consistent. This can often be difficult as road sign colours may have legal significance. This type of language demarcation is used in Scotland, as can be seen in Figure 3.3, although this is not always the case and some inconsistency exists.
2. **Font Type**: Differences in font type can be achieved through changes to the 'stroke' width used to form characters. Alterations of font size, however, are not commonly used as this can reduce the legibility of the words, especially at distance.

3. **Case:** In the Republic of Ireland, bilingual signs present English in capitals and Irish in lower case. There is no literature to support the presentation of names like this (Jamson, 2004) and a disadvantage in terms of the cultural value of languages is that it can suggest one language is dominant over another.
4. **Separation:** Providing a clear separation between different languages can improve glance legibility, especially for longer messages (Lesage, 1981). It has also been reported that monolingual drivers benefited most from clear separation between languages as demonstrated by reduced reading times (Lesage, 1981).

Figure 3.3: An example of the use of colour to differentiate between Gaelic and English on a bilingual road sign in Scotland

The principles of language demarcation on multilingual signs are part of the general requirement to achieve optimal attentional allocation from road sign design. Lansdown (2004) discusses factors involved in the design of standard road signs that are important for appropriate attentional allocation. These include: position, typographic features, colour and reflective/refractive properties (Lansdown, 2004). The design of bilingual and multilingual signs should aim to incorporate these factors as well as the additional attentional issues posed by the presentation of different languages.

3.4 Tourists

The relationship between tourism and transport is a fundamental one given that one facilitates the other (Lumsdon & Page, 2004); hence a greater understanding of tourist casualties on the roads in Scotland is an important consideration. In studies of US and Scottish citizens abroad, the second major cause of death after cardiovascular disease was injury and trauma (Hargarten, Baker & Guptill, 1991; Paixoa, Dewar, Cossar, Covell & Reid, 1991) respectively for US and Scottish citizens. Paixao *et al*. (1991) found that deaths through trauma were most likely to involve younger males, with road traffic accidents accounting for a large number of these. With road traffic accidents being a prominent factor in tourist deaths, anything that may reduce tourist safety on the road must be given important consideration.

Part of the reason behind introducing bilingual signs to trunk roads in the West of Scotland was to enhance the 'tourist experience'. While it is logical that the presence of Gaelic on road signs may increase tourists' experience of Scottish culture, there may be a road safety concern for tourists when considering the addition of Gaelic to road signs. The addition of place names in another language may cause added confusion to tourists, many of whom may not even be familiar with place names in English.

Walker and Page (2004) reviewed literature on tourists' road traffic accidents in Central Scotland. It is reported that while there is no evidence that foreign and UK visitor drivers are more likely than local drivers to be involved in an accident, there were differences in the main causes of accidents between UK residents and foreign drivers (Sharples & Fletcher, 2001). The average at fault UK resident driver was most likely to be involved in a crash that resulted from loss of control, negotiating a bend, or going too fast for the road conditions. On the other hand, foreign drivers were more likely to be involved in an accident due to driving on the wrong side of the road and turning and crossing the centre line; intuitively these 'foreign driver' accidents are more like the types of crash that we might expect from drivers who are distracted and/or overloaded than the collisions of residents. Thus, it is important to consider the road safety impact of bilingual directional road signs on tourists, especially if there is a case that bilingual signs may be a distraction, or may increase mental workload.

3.5 Other countries with multilingual road signs

Multilingual road signs are present in many countries, particularly in Europe. Their presence may be due to international borders, politics, or the preservation of a culture. The literature review established that formal documentation relating to multilingual signs in other countries was not generally available, and instead most information was sourced from the Euromosaic study (1996), the Ethnologue report (Gordon, 2005), and national censuses. Background information such as language statistics was sourced from web-based searches and publicly accessible information sites. In addition, contact was made with individuals and organisations with knowledge of practices and policies relating to multilingual signs in different countries. These included ministries of transportation, university academics, and members of FERSI (Forum of European Road Safety Research Institutes). Responses were received from the following organisations:

- Department of Transport, Ireland
- University of Edinburgh
- Welsh Assembly Government
- Department of Transportation, New Brunswick, Canada
- Department of Natural Resources, Nova Scotia, Canada
- Ministry of Transport, Quebec, Canada
- Ministry of Transportation, Ontario, Canada
- Transport Canada
- Federal Public Service of Mobility and Transport, Belgium
- Ministry of the German Speaking Community, Belgium
- Swiss Federal Roads Authority
- Finnish Road Administration
- Nova Scotia Department of Transportation and Public Works
- University of Trøms, Norway
- Research Institute for the Languages of Finland
- City Planning Department, City of Espoo, Finland
- Research Institute of Roads and Bridges, Poland
- Swedish National Road and Transport Research Institute
- Belgian Road Safety Institute
- Slovenian Roads Agency
- University of Queensland, Australia

A summary table with information from the countries reviewed in the literature review can be seen in Appendix A.

3.5.1 Wales

Of all the countries reviewed, Wales stood out as providing the most relevant literature for this report and is also comparable with Scotland in terms of geography, history and culture. Since 1993 Wales has been officially bilingual, with the Welsh Language Act establishing that the Welsh and English languages are to be treated on the basis of equality. According to the 2004 Welsh Language Survey, 22% of the population of Wales speak Welsh, with 57% of these considering themselves to be fluent.

The first provision for use of Welsh on a limited number of informatory traffic signs was made in 1970. The regulations enabled highway authorities to provide some kinds of bilingual signs, but did not oblige them to do so, and very few authorities used these powers (Bowen, 1972). A committee of inquiry was organised in 1970, chaired by Roderic Bowen, to consider the issues involved in the provision of bilingual road signs (Bowen, 1972). The inquiry was assisted by Rutley's (1972) research, discussed in section 3.2.2. As a result of the Bowen report, the Welsh Office decided to place bilingual road signs along trunk roads and on side roads or secondary roads which were under the authority of local councils (Grin & Vaillancourt, 1999). It was decided that the order of languages on bilingual signs should be determined by each local authority and as a consequence language order in signs across Wales is inconsistent and depends on each authority area.

There is no language demarcation on road signs in Wales; both English and Welsh are displayed in the same font and colour. This is because to demarcate the languages may be seen as giving precedence to one language over the other.

Implementation of bilingual road signs occurred at different paces depending on the local authorities concerned (with counties with a higher proportion of Welsh-speakers generally installing bilingual signs first), and at present practically all road signs in Wales are bilingual (Grin & Vaillancourt, 1999).

A review of bilingual road signs in Wales was reported by Ryder (1980). The review reported that it was unlikely that there were any general adverse effects resulting from the installation of bilingual road signs in Wales. However, the analysis of accident data carried out for this review was somewhat basic, as acknowledged by the author (Ryder, 1980). The analysis compared overall accident trends between Wales and the rest of Great Britain over a nine year period. There was no control for accident rates before and after the installation of bilingual signs on any particular route, nor any attempt to control for other road safety influences occurring at the time. The analysis was therefore not detailed enough to capture anything other than a major change in accident rates. A small, yet still meaningful, change would be missed in such analysis.

3.5.2 Other countries

Multilingual road signs are present in a number of other countries. The reason for their presence varies and may be due to international borders, politics, or the preservation of a culture.

Perhaps the most important finding from the review of multilingual sign implementation in other countries is that there is a scarcity of research into the safety impact of multilingual signs and also a lack of information regarding guidelines for implementing multilingual signs. Only Switzerland and Denmark appear to have considered road safety effects, rejecting multilingual signs on the grounds that they may have a detrimental influence on road safety. Following correspondence with and visits to other countries, the Bowen Committee (1972) report states:

> "We raised the question of road safety in relation to existing bilingual signs with those responsible. The main reaction was one of surprise. They conceded that they had no precise information but said they had no reason to think that there was any adverse effect on road safety." (p48)

Baguley and Cooper (2000) also reached a similar conclusion, saying that "…little research has been carried out into the effects of bilingual signs on road safety" (p1). It appears that most countries presume that there is little or no effect of multilingual signs on road safety.

3.6 Summary

The literature review identified that there are very few published examples of scientific literature researching the specific effect of bilingual signs on driver behaviour and road safety. Nevertheless, based on the research that is available, and research from alternative driving domains, some tentative conclusions can be drawn.

In other countries in which bilingual signs have been introduced, there have not been many systematic attempts to quantify any effects on road accident statistics, and with the exception of Switzerland and Denmark, road safety has not really been a consideration when making the decision to introduce multilingual signage or not. Although Ryder (1980) concluded on the basis of an analysis of accident data that there was no effect of the introduction of such signs in Wales, there are considerable limitations to the methods used that limit our ability to extrapolate this result to the Scottish context.

There is an established research literature demonstrating the effect of distraction, in many forms, on driving behaviour and accident risk. While the precise mechanism and role of workload and distraction can be debated, it is undeniable that humans have limited processing capacity and additional tasks when driving can highlight these limitations. Jamson *et al*. (2005) showed that various driving behaviours suffered when participants in a driving simulator were asked to encounter four-line signs rather than two-line signs, suggesting that complex signs had a workload-increasing or distracting effect. Rutley's (1972; 1974) experiments of Welsh and English bilingual signs demonstrated that the bilingual signs took longer to read than English only signs. Jamson *et al*. also showed that four-line signs resulted in a speed reduction and that the bilingual signs caused a 'hangover effect' on drivers' speed management, an indication that drivers were in some way distracted or overloaded by the information on the bilingual signs. Nevertheless, a speed reduction could also be regarded as a potential road safety benefit, as long as its benefits are not outweighed by any concomitant mental workload or distraction effects.

An analysis of accident types experienced by resident and tourist drivers in Scotland by Walker and Page (2004) suggests that accidents involving tourists intuitively seem more likely to be caused by distraction and workload than those accidents experienced by residents. As tourists are more likely to rely on signs than residents, it may be that introducing bilingual signage may add to an existing workload or distraction decrement for tourist drivers.

In summary, from the literature review we can conclude that there are some findings that suggest bilingual signs may have a distracting or workload-inducing effect on drivers, and that this could in theory cause an increase in crash risk on roads in Scotland (possibly especially for tourists). There is a paucity of robust analysis of accident data from other countries that have introduced bilingual or multilingual signage. It is prudent to conclude, therefore, that any impact on driver workload that may arise from a change to the road system should be considered seriously.

4 Accident Analysis

4.1 Introduction

In this section we compare the number of accidents that occurred on the trunk roads on which bilingual signs were installed before and after the installation of the signs. In order to do this in a robust way it was necessary to allow for general trends in accidents. Comparison routes in Scotland were chosen which were similar in characteristics to the bilingual routes but on which bilingual signs were not installed. The accident trends on these comparison routes were assumed to be similar to those that would have occurred on the bilingual routes had the signs not been installed. Section 4.2 explains the process of choosing these comparison routes, and Section 4.3 compares their road, traffic and accident characteristics to the bilingual routes.

Two types of statistical analysis have been used to compare the accident patterns before and after the bilingual signs were installed. Section 4.4 contains the results of a before and after comparison based on individual routes and groups of routes. Routes have been grouped together where bilingual signs were installed concurrently. Section 4.5 combines all the routes together and uses a modelling approach to assess the overall difference in accident trends before and after the signs were installed. Both of these analyses allow for changes in traffic flows and general changes in accident trends derived from the comparison routes. The more complex modelling approach used in Section 4.5 facilitates combining all the 'before' installation of bilingual signs data which can be compared with all the 'after' installation data while taking into account underlying seasonality and trend effects. The model can also include a factor to allow for route differences. In contrast, the analysis in Section 4.4 is constrained to being able to compare routes only where bilingual signs were installed in the same month; seasonality between the before and after periods may not be fully allowed for.

4.2 Data and methodology

4.2.1 Bilingual routes

As part of the Scottish Government's current bilingual signing strategy, nine routes in Scotland, shown in Table 4.1, had bilingual signs installed between April 2004 and August 2008. An additional route (route 10) also had bilingual signs installed but it is unknown when installation was completed and so this route has been excluded from the analysis.

For each route, the exact date or period of installation was unknown, and therefore a month either side of the completion month stated was excluded from the analysis, as shown in Figure 4.1. For example, on routes 1-3 the bilingual signs were installed in May 2004. Therefore the 'before' period was defined as January 2000 to the end of March 2004 (51 months); the 'after' period was defined as July 2004 to the end of December 2009 (66 months).

Table 4.1: Bilingual sign routes

Bilingual Route	Road	Description	Completion date
1	A87	Broadford to Uig	May 2004
2	A87	Invergarry to Skye Bridge	May 2004
3	A887	Invermoriston to A87	May 2004
4	A835	Ullapool to Dingwall/Tore	August 2005
5	A830	Fort William to Mallaig	April 2004
6	A828	Connel to Ballachulish	October 2006
7	A85	Oban to Tyndrum	July 2007
8	A82	Tarbet to Fort William	August 2008
9	A82	Fort William to Inverness	August 2008
10	A87	Skye Bridge to Broadford	Unknown

4.2.2 Comparison routes

To compare the number of accidents before and after any intervention, figures from the treatment routes (in this case the bilingual sign routes) need to be compared with comparison routes, which are similar except for having no intervention. This allows for any background trend in accidents due to factors unrelated to the intervention. Routes with similar road characteristics, traffic flow and accident trends were chosen and these are shown in Table 4.2. A map of the comparison routes is shown in Figure 4.2.

Across all roads in Scotland (Scottish Government Statistics, 2009) the total number of injury accidents in 2008 was 12,149 which is an overall reduction of 26% and a reduction in fatal accidents of 27% compared with the baseline 1994–1998 average. If the analysis of accident rates before and after the bilingual signs were installed did not account for this general decrease in accident numbers then the impact of the signs could be misinterpreted.

Table 4.2: Comparison routes

Route number	Road	Description
21	A77	South of Ayr
22	A84	Stirling to Lochearnhead
25	A7	all
26	A90	Ellon to Fraserburgh
28	A99	all
29	A86	all
30	A85	Perth to A82
31	A76	all
32	A95	all
33	A83	all
34	A9	N of Tore roundabout

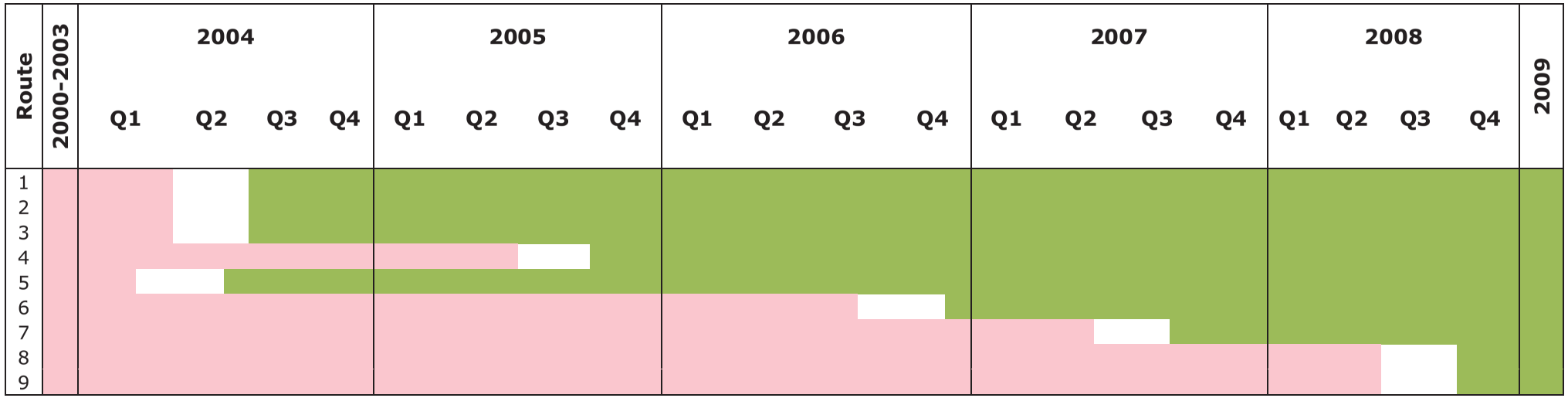


Figure 4.1: Calendar of installations with before and after periods used

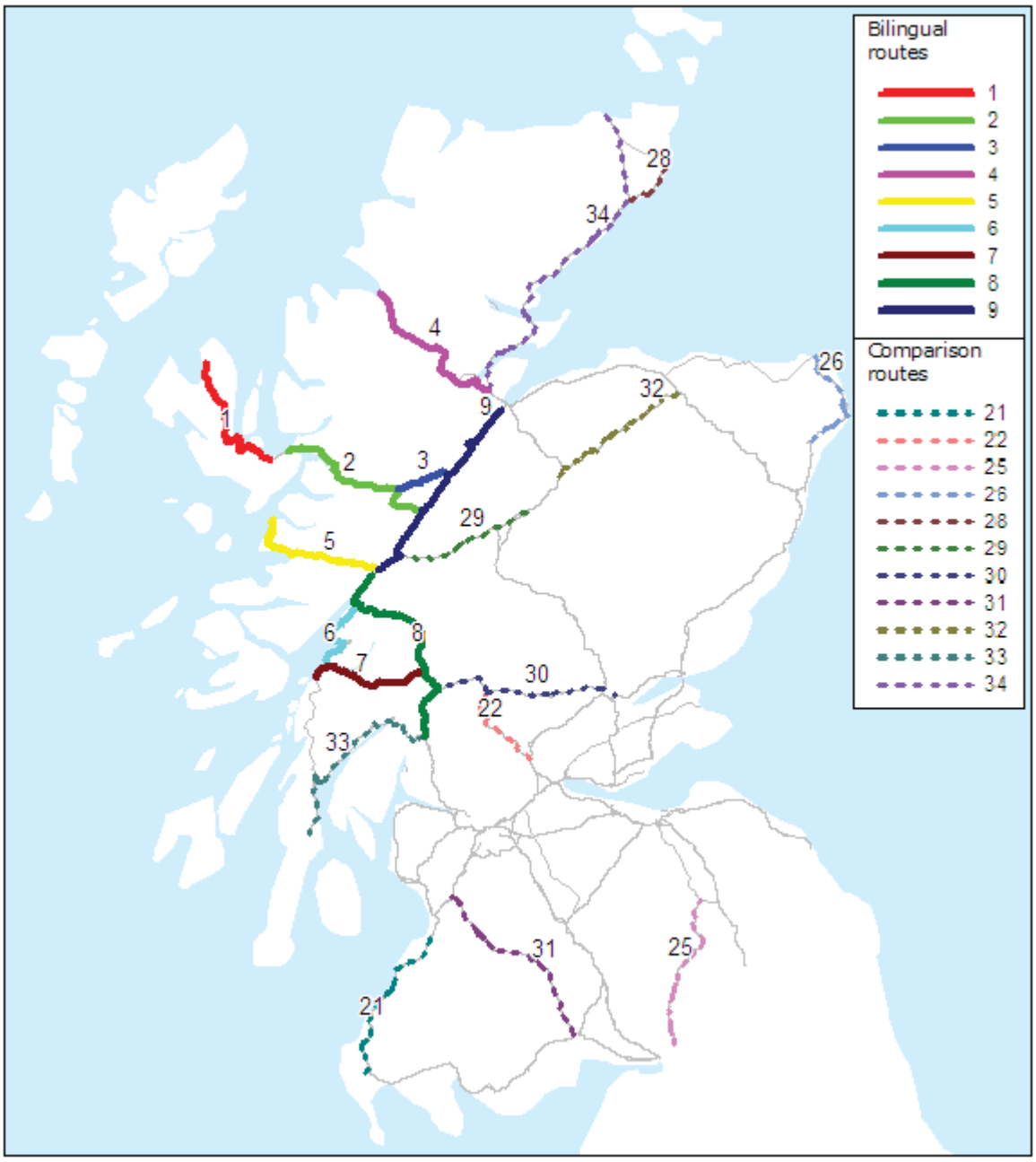


Figure 4.2: Map of bilingual sign and comparison routes

4.2.3 Data

For each route, the road characteristics, flow data and accident data were extracted. These data were used in the analyses described in Sections 4.4 and 4.5 and to help assess how well the possible comparison routes matched with the bilingual routes (prior to the installation of the signs).

The available route characteristics were section type (for example, dual and single carriageway) and speed limit. The length of each route was also recorded for use in the main analyses.

Flow data were used to calculate the annual average daily traffic flow (AADT) of all vehicles, powered two wheelers (PTWs) and Heavy Goods Vehicles (HGVs) on each of the routes. Combining the AADT values with the length of each route and monthly factors produced estimates of traffic (measured in million vehicle kilometres) in each month on each route.

The Stats19 accident data was provided by Transport Scotland and included the following:

- Accident severity
- Junction detail
- Vehicle type
- Vehicle manoeuvre
- Month

4.3 Bilingual and comparison routes

Nine bilingual routes and 11 comparison routes have been defined in Section 4.2. In this section the average values on relevant variables for these bilingual routes and comparison routes are compared. These comparisons are based on data between 2000 and 2003; that is before the installation of the bilingual signs. The main results are presented here and detailed tables and graphs can be found in Appendix B.

4.3.1 Road characteristics

The vast majority of the bilingual (99.0%) and comparison routes (99.3%) were single two-lane carriageway, and the majority of the routes were also subject to a 60mph speed limit (89.9% of bilingual routes and 91.6% of comparison routes). The speed limits on the remaining sections of the bilingual routes were 30mph (5.0%) and 40mph (5.1%). On the comparison routes remaining speed limits were 30mph (6.9%) and 40mph (1.3%) with the remaining 0.2% of comparison routes having a 70mph speed limit or a speed limit that was unknown.

Overall, the road characteristics of the two groups of routes were similar in road type and speed limit distribution.

4.3.2 Traffic flow

The flow data were used to assess the similarities in the vehicle flows on the bilingual and comparison routes. Flow was assessed in terms of the AADT and how this changed between 2000 and 2009. In addition, the proportion of traffic that was PTW and HGV was also compared. The summary data are shown in Table 4.3.

In both 2000 and 2009 the bilingual routes generally had lower AADTs than on the comparison routes. The average flow increased for both sets of routes over this period, but greater increases were seen on the comparison routes.

In both 2000 and 2009, the bilingual routes had a higher proportion of PTW traffic and a lower proportion of HGV traffic compared with the comparison routes. The growth in PTW traffic on the bilingual signs routes over the period was much greater than the growth on the comparison routes.

Table 4.3: Flow data

Measure		Bilingual	Comparison
Number of routes		9	11
Length (km)		618	862
2000 AADT	All vehicles	2,735	3,613
	PTWs	42	31
	HGVs	136	317
	%PTW	1.5%	0.9%
	%HGV	5.0%	8.8%
2009 AADT	All vehicles	2,975	4,376
	PTWs	75	44
	HGVs	172	383
	%PTW	2.8%	1.2%
	%HGV	6.3%	10.6%
% change in AADT	All vehicles	9%	21%
	PTWs	81%	40%
	HGVs	26%	21%

4.3.3 Accidents

Table 4.4 shows the distribution of accidents by severity.

Table 4.4: Accidents by accident severity (2000–2003)

Accident severity	Bilingual routes	Comparison routes
Fatal	5%	5%
Serious	33%	31%
Slight	62%	64%
Total accidents (100%)	763	1,367

The overall proportions of KSI and slight accidents were comparable between bilingual (prior to the installation of the signs) and comparison routes.

There was a greater proportion of accidents at junctions on the comparison routes (35% on comparison routes compared to 21% on bilingual routes), especially T-junctions, suggesting that there were either more junctions on the comparison routes, or that the junctions on the bilingual routes posed a lower risk.

The traffic data showed that there was a greater proportion of PTWs in the traffic on the bilingual routes compared with the comparison routes. The number of accident-involved vehicles by vehicle type is shown in Table 4.5.

Table 4.5: Accident-involved vehicles by vehicle type (2000–2003)

Vehicle type	Bilingual routes	Comparison routes
Pedal cycle	1.0%	1.6%
PTW	13.4%	7.8%
Car	73.0%	76.5%
Bus or coach	1.5%	1.0%
LGV	4.0%	3.3%
HGV	5.3%	7.8%
Other or unknown	1.8%	2.0%
Total vehicles (100%)	1,295	2,422

Matching with the traffic flow information, there was a greater proportion of accident-involved PTWs (13%) on the bilingual routes compared with the comparison routes (8%), and the proportion of HGV involved accidents was slightly lower on the bilingual routes.

On the bilingual routes there was a greater proportion of accidents involving vehicles which were travelling around bends.

4.3.4 Accident rates

The accident rate on a route gives the risk of an accident occurring on a route. This is calculated as the number of accidents per vehicle kilometre. Table 4.6 shows the average accident rate for the comparison routes compared with the bilingual sign routes.

Table 4.6: Accident rates (2000-2003)

Measure	Bilingual routes	Comparison routes
Length (km)	640.4	1029.4
AADT	3543	5865
Total traffic, 2000-2003 (10^6 veh-km)	0.33	0.88
Accidents 2000-2003	763	1,367
Accident rate (accidents per 10^6 veh-km)	0.23	0.16

Overall, the rate of accidents on bilingual routes (before sign installation) was higher than on comparison routes.

4.3.5 Summary

Overall the selected comparison routes show an adequate match to the bilingual sign routes, before installation. There are some differences between the routes although it is possible to account for these remaining differences during the analyses.

It should be noted that comparisons were carried out on the combination of all bilingual routes and all comparison routes, and this does not necessarily guarantee that individual bilingual routes are well represented by the set of comparison routes.

4.4 Individual route analysis

Section 4.3 has shown that the comparison routes were generally comparable to the bilingual routes. In Section 4.4 we compare accident rates before and after the installation of the bilingual signs given the general accident trends shown on the comparison routes, using the Hauer methodology (Hauer, 1997).

4.4.1 Analysis methodology

The analysis compares the number of accidents before and after an intervention, with a comparison route. The method uses the comparison data to estimate the expected number of accidents in the 'after' period on the intervention route. Expected values are then compared with their corresponding observed values, and in each case a statistical test is used to assess whether there is a statistically significant difference between the observed and expected figures. Any significant difference may be considered to be due to the intervention, given certain assumptions.

In this case, accident rates before the bilingual signs were installed have been compared with the accident rates after installation, taking into account the general trend in accident rates over the same period (defined by the comparison routes). Since bilingual signs were installed across the routes at different times, the before and after periods are different for each route. Each route installed with bilingual signs is analysed separately (except for routes 1-3, which were all installed in May 2004, and routes 8 and 9 which were both installed in August 2008) all using the same set of comparison routes, but using the 'before' and 'after' periods from the comparison routes that were appropriate to each bilingual route being studied (see Figure 4.2).

Analysis was first carried out for the total number of accidents. Several subsets of different accident types which were thought to be particularly relevant to bilingual signs were also analysed.

4.4.2 Analysis assumptions

The Hauer method used in this analysis uses the following assumptions:

a) Any factors affecting accident rates (for example, general engineering improvements) have changed from the 'before' and 'after' periods in the same manner on both the bilingual and comparison routes.

b) Any changes in these factors influence the safety of the bilingual and comparison routes in the same way.

c) The comparison routes are similar to the individual bilingual routes in terms of road type, conditions and any other factors that may affect road safety. Comparison routes are hence assumed to be comparable to bilingual sign routes apart from having bilingual signs.

d) The distribution of the expected number of accidents follows a Poisson distribution.

4.4.3 Results

4.4.3.1 *All accidents*

Table 4.7 shows the number of accidents on each of the routes in the before and after periods, and for the same periods on the set of comparison routes. Since each route is compared with all of the comparison routes, the number of accidents on the comparison routes is much greater. Bilingual routes 1 to 3, and 8 and 9, have been combined since the installation dates were the same.

Table 4.7: Number of accidents by route before and after bilingual sign installation

Route	Months		Bilingual route		Comparison route	
	Before	After	Before	After	Before	After
1-3	51	66	149	222	1,431	1,897
4	66	51	89	63	1,880	1,439
5	50	67	51	63	1,403	1,928
6	80	37	62	27	2,304	1,040
7	89	28	226	89	2,546	795
8-9	102	15	780	108	2,898	443

Because of the differences in traffic flow and route length, it would not make sense to estimate the impact of bilingual signs from the raw numbers of accidents; they are presented here for information only. Instead, a rate of accidents, that takes into account traffic flow and route length, is required.

The numbers of accidents per million vehicle kilometres for each of the bilingual and comparison routes, both before and after the signs were installed, are shown in Table 4.8. Also included in this table are the differences between the comparison and bilingual routes and the statistical significance of this difference. This is defined as the difference between the expected accident rate (as calculated from the rate on the comparison routes over the same time periods) and observed accident rate on the bilingual sign routes after the installation of the bilingual signs. This difference takes into account the exposure data. A positive difference suggests an increase in accident rate relative to the general trend. A significant result ($p<0.01$, $p<0.05$ or $p<0.10$) from the statistical test carried out on this difference suggests that it is significantly different from zero, that is, there is a 99%, 95% or 90% chance respectively that this change is 'real' and not due to underlying 'random' variation in the data.

In general, Table 4.8 shows that for all accidents, the accident rates on the comparison routes decreased in the 'after' period, showing that the expected trend without intervention was a reduction in accident rate. For two groups of bilingual routes: routes 1-3 (A87 & A887) and route 7 (A85), the accident rate increased in the after period.

When all accident types are considered, the difference between the expected and the observed numbers of accidents when bilingual signs were installed was statistically significant for the route 1-3 (A87 & A887) combination only (at the 5% level). The results show that the accident rate is higher on the bilingual routes after the bilingual signs had been installed, than would have been expected given the general trend.

Table 4.8: Accident rates[6] by route before and after bilingual signs

Route	Bilingual route		Comparison routes		Difference[7]	Significance
	Before	After	Before	After		
1-3	0.251	0.309	0.270	0.248	33.1%	p<0.05
4	0.210	0.172	0.268	0.242	-10.4%	ns
5	0.290	0.221	0.270	0.248	-18.4%	ns
6	0.209	0.178	0.267	0.240	-7.1%	ns
7	0.384	0.453	0.264	0.243	27.1%	ns
8-9	0.322	0.319	0.259	0.254	0.6%	ns
Significance value of ns shows that the change is not statistically significant at the 10% level						

4.4.3.2 *Killed or serious injury accidents*

Table 4.9 shows the accident rates of fatal and serious accidents for each of the bilingual and comparison routes, both before and after the signs were installed. The numbers of KSI accidents are shown in Table B.12 in Appendix B. The difference in accident rates when bilingual signs were installed compared to when no signs installed is not statistically significant for any of the routes, indicating that any difference between the accident rates on the bilingual routes before and after the signs were installed is likely to be due to the general trend in accident rates.

Table 4.9: KSI accident rates by route before and after bilingual signs

Route	Bilingual route		Comparison routes		Difference	Significance
	Before	After	Before	After		
1-3	0.076	0.058	0.098	0.067	9.6%	ns
4	0.092	0.071	0.092	0.066	5.0%	ns
5	0.068	0.053	0.098	0.068	2.9%	ns
6	0.057	0.079	0.090	0.063	83.9%	ns
7	0.138	0.092	0.088	0.061	-6.9%	ns
8-9	0.110	0.074	0.084	0.065	-15.1%	ns
Significance value of ns shows that the change is not statistically significant at the 10% level						

4.4.3.3 *Slight injury accidents*

Table 4.10 shows that the difference between the expected and observed number of accidents involving only slight injuries on the bilingual routes is significant for routes 1–3, 5, 6 and 7. The numbers of slight injury accidents are shown in Table B.13 in Appendix B. On routes 5 and 6 there was a negative difference suggesting that there had been a bigger reduction in the accident rate than expected given exposure and the general background trends. For routes 1–3 and route 7 a positive difference was detected showing that the observed rate for slight accidents on the bilingual routes after

[6] Accident rates calculated by million vehicle kilometres.
[7] Difference in the ratio of safety with the treatment to what it would have been without the treatment. This percentage is calculated using the raw accident counts following the method outlined by Ezra Hauer in 'Observational Before-After Studies in Road Safety'.

the signs had been installed was larger than that which was expected given the general trend provided by the comparison routes.

Table 4.10: Slight accident rates by route before and after bilingual signs

Route	Bilingual route		Comparison routes		Difference	Significance
	Before	After	Before	After		
1-3	0.175	0.250	0.172	0.180	34.8%	p<0.05
4	0.118	0.101	0.176	0.176	-16.3%	ns
5	0.222	0.169	0.172	0.180	-29.1%	p<0.10
6	0.152	0.099	0.177	0.177	-36.3%	p<0.10
7	0.246	0.361	0.176	0.182	40.9%	p<0.10
8-9	0.212	0.245	0.175	0.189	6.8%	ns
Significance value of ns shows that the change is not statistically significant at the 10% level						

4.4.3.4 *Junction accidents*

Bilingual advanced direction signs are generally placed on the approach to junctions. Twenty-one percent of accidents on the bilingual routes occurred within 20m of a junction. The numbers of junction accidents are shown in Table B.14 in Appendix B. As shown in Table 4.11 there is no significant difference between the rates of accidents expected and observed on bilingual routes after the signs have been installed. In other words, any changes in accident rates in the before and after period are likely to be due to the general trend in accident rates.

Table 4.11: Junction accident rates by route before and after bilingual signs

Route	Bilingual route		Comparison routes		Difference	Significance
	Before	After	Before	After		
1-3	0.045	0.051	0.095	0.079	31.9%	ns
4	0.066	0.041	0.096	0.072	-20.9%	ns
5	0.063	0.056	0.095	0.079	-1.1%	ns
6	0.057	0.026	0.093	0.075	-46.2%	ns
7	0.100	0.076	0.090	0.075	-10.4%	ns
8-9	0.049	0.056	0.088	0.080	23.4%	ns
Significance value of ns shows that the change is not statistically significant at the 10% level						

4.4.3.5 *Powered two wheeler-involved accidents*

Table 4.12 shows that the difference between observed and expected rate of PTW accidents after bilingual signs had been installed was statistically significant at the 10% level for route 4 (A835). This difference was negative indicating that the accident rate at this route reduced more than was expected given the general trend in accidents. The numbers of PTW accidents are shown in Table B.15 in Appendix B.

Table 4.12: PTW-involved accident rates by route before and after bilingual signs

Route	Bilingual route		Comparison routes		Difference	Significance
	Before	After	Before	After		
1-3	0.039	0.053	0.034	0.024	80.9%	ns
4	0.059	0.030	0.032	0.025	-39.2%	p<0.10
5	0.045	0.028	0.034	0.024	-23.6%	ns
6	0.037	0.020	0.032	0.022	-30.7%	ns
7	0.068	0.051	0.031	0.020	11.1%	ns
8-9	0.063	0.053	0.031	0.021	21.6%	ns
Significance value of ns shows that the change is not statistically significant at the 10% level						

4.4.3.6 *Car-involved accidents*

The observed accident rates for car accidents are shown in Table 4.13. The numbers of car accidents are shown in Table B.16 in Appendix B. The difference between the expected and observed rates of car accidents after the bilingual signs had been installed is statistically significant for two groups of routes. A positive difference was shown for routes 1–3, suggesting that the observed rate of car accidents was higher once the bilingual signs had been installed than could be explained by the trend shown on the comparison routes. On route 5 (A830), an opposite result suggested that after the installation of the bilingual signs, the observed accident rate was significantly lower than could be explained by the general trend in accidents.

Table 4.13: Car-involved accident rates by route before and after bilingual signs

Route	Bilingual route		Comparison routes		Difference	Significance
	Before	After	Before	After		
1-3	0.211	0.261	0.234	0.212	36.0%	p<0.05
4	0.158	0.134	0.232	0.206	-6.1%	ns
5	0.267	0.183	0.235	0.212	-25.8%	p<0.10
6	0.165	0.138	0.230	0.205	-8.0%	ns
7	0.330	0.381	0.227	0.208	25.4%	ns
8-9	0.258	0.274	0.222	0.219	7.6%	ns
Significance value of ns shows that the change is not statistically significant at the 10% level						

4.4.3.7 *Seasonal accidents*

Many of the bilingual routes have higher traffic flows during summer months, probably due to tourist traffic. Table 4.14 and

Table 4.15 record the accident rates for bilingual and comparison routes before and after the installation of the bilingual signs during the summer months (defined as April to September) and winter months (October to March) respectively. The numbers of accidents in the summer and winter months can be seen in Tables B.17 and B.18 in Appendix B.

During the summer months the difference between the observed and expected accident rates is statistically significant on route 5 only. The difference is negative suggesting that a lower accident rate occurred once the bilingual signs had been installed than was expected given the general trend defined by the comparison routes. During the winter months a statistically significantly greater accident rate was observed after the bilingual signs were installed at routes 1–3 and route 7 than was predicted by the comparison route trend.

Table 4.14: Summer accident rates by route before and after bilingual signs

Route	Bilingual route		Comparison routes		Difference	Significance
	Before	After	Before	After		
1-3	0.263	0.304	0.252	0.246	17.4%	ns
4	0.217	0.171	0.259	0.234	-14.7%	ns
5	0.269	0.186	0.252	0.246	-31.3%	p<0.10
6	0.243	0.193	0.259	0.232	-13.0%	ns
7	0.390	0.373	0.255	0.240	1.0%	ns
8-9	0.338	0.382	0.249	0.272	2.9%	ns
Significance value of ns shows that the change is not statistically significant at the 10% level						

Table 4.15: Winter accident rates by route before and after bilingual signs

Route	Bilingual route		Comparison routes		Difference	Significance
	Before	After	Before	After		
1-3	0.232	0.316	0.289	0.250	54.0%	p<0.10
4	0.199	0.172	0.281	0.251	-6.1%	ns
5	0.322	0.284	0.290	0.250	-2.5%	ns
6	0.149	0.154	0.276	0.250	6.7%	ns
7	0.376	0.554	0.274	0.247	61.2%	p<0.05
8-9	0.294	0.248	0.272	0.241	-5.3%	ns
Significance value of ns shows that the change is not statistically significant at the 10% level						

4.4.4 Summary of individual route analysis

Table 4.16 summarises all of the statistically significant results that were found, for each of the routes. At routes 1–3 and route 7 the accident rate for certain accident types after the bilingual signs had been installed was significantly higher than could just be explained by the general trend. On routes 4, 5 and 6 the opposite was found, with accident rates for certain accident types being significantly lower than that which would have been expected by just allowing for the general trend.

There were no statistically significant effects on the number of accidents involving a fatal or serious injury (KSI), suggesting that the pattern in the more severe accident trends on the bilingual routes was no different from the general trend in KSI accidents.

In addition, no unexpected differences between the before and after periods were found for junction accidents, which, given that many of the bilingual signs are likely to have been installed near junctions, suggests that statistically significant changes that were

found (summarised in Table 4.16) may have been due to other changes on the routes rather than the installation of the bilingual signs.

Table 4.16: Summary of significant results obtained by route, using the Hauer method

Route	Accident type	Significance	Observed (compared to expected) number of accidents was:
1-3	All accidents	p<0.05	Higher
1-3	Car accidents	p<0.05	Higher
1-3	Slight accidents	p<0.05	Higher
1-3	Winter months	p<0.10	Higher
4	Motorcyclists	p<0.10	Lower
5	Car accidents	p<0.10	Lower
5	Slight accidents	p<0.10	Lower
5	Summer months	p<0.10	Lower
6	Slight accidents	p<0.10	Lower
7	Slight accidents	p<0.10	Higher
7	Winter months	p<0.05	Higher

4.5 Combined route analysis

4.5.1 Analysis methodology

Section 4.4 used the Hauer method in a matched 'before and after' study to look at the effect of installing bilingual signs on various trunk routes in Scotland. The Hauer approach is well established and provided that the 'before' and 'after' periods for the treatment routes (i.e. bilingual sign routes) can be matched to equivalent comparison routes it provides a simple and appropriate method for analysis. However, this approach does not allow for differences between routes or for other factors which may have an impact on accident risk (for example seasonal variation). A more sophisticated approach which can take into account potential influences on accident liability may be able to explain more of the variation in the data and so may be able to determine more precisely any influence of, for example, the impact of installing bilingual signs. As can be seen in Figure 4.3, traffic flow (annual average monthly flow by length of route) was generally lower on the bilingual routes than on the comparison routes but with a similar 'pattern' of monthly fluctuations. A different statistical method is required in order to include other factors such as this.

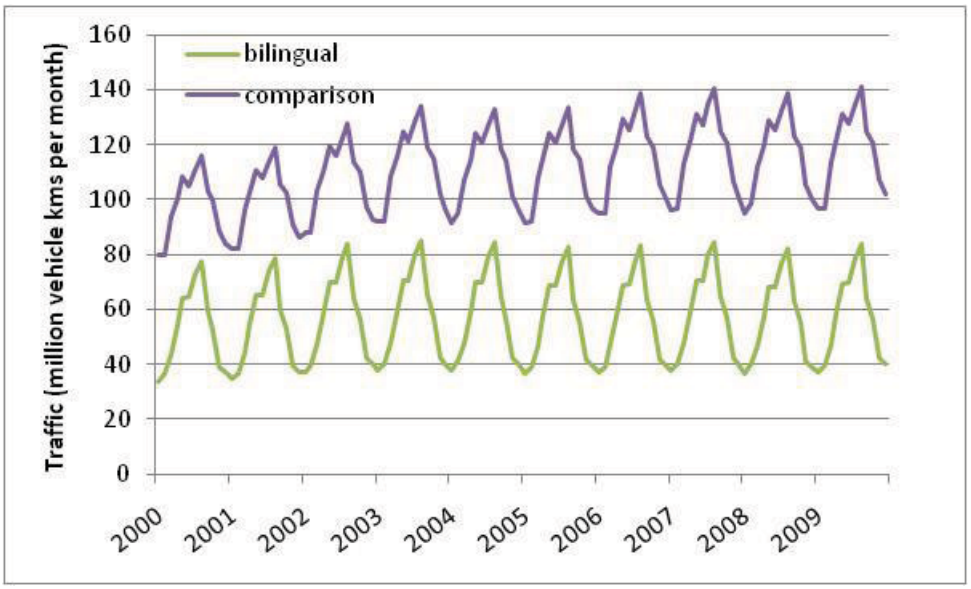


Figure 4.3: Traffic flow (vehicles per month by length of route)

An appropriate statistical approach is to use a generalised linear model which models accident risk as a function of exposure. Factors are included in the model to allow for changes in accident risk with time. Year and month factors were modelled as a combination of year plus month which allows for some variation for months in different years. The parameters associated with monthly factors control for any underlying trend and seasonality in the data. These parameters are shown in Figure B.5 in Appendix B.

Accidents do not follow a Normal (Gaussian) distribution since, in general, they are relatively rare events and it is possible for there to be no accidents within a reporting period. Accidents have been assumed to follow a Negative Binomial[8] distribution, which allows for a relatively low number of accidents and for some periods having zero accidents. A monthly reporting period is used for this study (from January 2000 to December 2009) for the comparison and bilingual routes.

The statistical model explains the number of accidents per month taking into account the exposure, trend and seasonal effects based on the comparison route data and the bilingual sign route data prior to the installation of bilingual signs. A factor is included in the model to allow for any difference between the set of comparison routes and the set of bilingual routes.

The statistical model took the following form (note: the log of accidents is modelled which Normalises the residual errors or 'noise'):

$$\log_e(\text{accidents}_{nk}) = a_o + a_1 \log_e(\text{exposure}_{nk}) + b_k + \text{route} + \varepsilon_{nk}$$

where

there are *nk* observations (*n* time periods of 1 per month for 10 years for each of *k* routes)

a_o is an overall constant

a_1 is the parameter associated with the exposure measure (a_1 may be set to 1 by declaring $\log_e$(exposure) as an offset in the model)

[8] A Poisson distribution is also often used when modelling accidents, however if there is over-dispersion in the spread of accidents, relative to what would be expected with a pure Poisson distribution, then an adjustment factor is required. Using the Negative Binomial distribution avoids this potential complication.

b_k are the parameters associated with each month and year combination (k=1…120); note this model requires more parameters (than just modelling year and month) but allows for a variation in seasonality.

route is a factor for bilingual route (*route*=1) or comparison route (*route*=0), which can also be extended to allow for individual route difference within the bilingual and comparison routes ($route_j$=1 for j^{th} route or =0 otherwise, where j=1…20)

ε_{nk} is the residual 'noise' not explained by the model

Initially this model has been used to predict the expected number of accidents taking into account seasonality, yearly trends, exposure and if the route is bilingual or comparison. (It was also extended to allow for route differences.) The observed accidents for just bilingual routes are then compared with the predicted values and the difference between the expected and observed number of accidents after the bilingual signs have been installed is defined by an 'after' factor in the following model.

$$\log_e(accidents_m) = a + \log_e(predicted_m) + after + \varepsilon_m$$

where

there are m bilingual route observations

a is an overall constant

after is a factor for the bilingual sign (*after*=1) or no sign (*after*=0)

ε_m is the residual 'noise' not explained by this model

The statistical significance of the 'after' factor indicates if the bilingual signs have any significant effect on the accident type being analysed. The size of any effect is determined from the ratio of the observed accident rate relative to the predicted (or expected) accident rate, where the rate takes into account exposure and other factors. A number of different types of accident have been considered:

- All
- All killed or seriously injured (KSI)
- All car involved
- Car involved with a KSI
- All powered two vehicles
- Powered two vehicles with a KSI
- All close to a junction
- All close to a junction and KSI
- All accidents in the summer (April to September)
- All accidents in the winter (October to March)

4.5.2 Analysis assumptions

The modelling analysis depends on a series of assumptions:

a) That the comparison routes and the bilingual routes are similar sample subsets from the same population of Scottish roads, with for example:
   i) Similar sections of 20mph, 30mph and 40mph restrictions
   ii) Similar numbers of junctions
   iii) Similar numbers of road signs per kilometre of road
   iv) Similar lengths of different road types, i.e. urban, rural, single carriageway etc.
b) The seasonal and annual effects are identical for both subsets of routes regardless of the type of accident being considered.
c) The relationship between accident risk and exposure is the same for both subsets of routes, (this assumption was relaxed in the model which included a factor for route differences).

d) The relationship between accident risk and exposure may vary for different types of accident but will be the same for both subsets. It is assumed that accidents and exposure are not necessarily linearly related, i.e. the exposure measure has an associated parameter such that accident rate = accidents/exposure^{a1} where a1 is a constant.
e) The error terms within the generalised linear model can be represented by the negative binomial distribution.

Violation of these assumptions may influence the conclusions reached from the analysis. However, they are reasonable and some can be examined.

4.5.3 Results

The first approach to the analysis was to include all data from the time periods during which bilingual signs were being introduced. However, upon closer inspection of the data, it was established that there was a problem with this approach in that over the period between April 2004 and September 2008, different subsets of the bilingual routes had signs installed at different times. Specifically, routes 1–3 (A87 & A887) and 5 (A830), which were given bilingual signs first, also had some of the lower accident rates to begin with (see Section 4.4.3). This means that during the transitional period there is a risk that changes in accident rate that are attributable to pre-existing site differences may be misinterpreted as being associated with the introduction of bilingual signs.

After consideration of these issues, it was decided that two approaches should be taken. First, a conservative approach was employed in which only those data before any bilingual signs had been installed on any route, and those data after all bilingual signs had been installed on all routes, were used for the analysis. This analysis thus compared data from January 2000 to March 2004 (with no signs) with October 2008 to December 2009 (all bilingual routes with signs). The exclusion of the transitional period between these dates, when bilingual signs were being installed on the network but at different times on different subsets of the bilingual routes, ensures that the comparison routes and bilingual routes being used in the analysis are matched for pre-existing accident rate.

Table 4.17, gives the observed rates per million vehicle km for the comparison routes and the bilingual routes before and after the installation of bilingual signs. It also shows the estimated effect size of installing bilingual signs together with deviance explained and its associated statistical significance.

Table 4.17: All months pre-March 2004 and post-Sept. 2008, analysis of effect size

Accident type	Comparison	Bilingual				
		Before	After			
	Observed rate	Observed rate	Observed rate	Effect	Deviance	Significance
All	0.266	0.284	0.293	4.2%	0.2	ns
All KSI	0.090	0.106	0.075	2.4%	0.1	ns
Car	0.230	0.232	0.249	6.3%	0.8	ns
KSI car	0.074	0.082	0.059	10.4%	0.6	ns
PTW	0.031	0.056	0.047	Model did not converge		
KSI PTW	0.017	0.032	0.021	Model did not converge		
Junction	0.092	0.059	0.047	-2.1%	0.1	ns
KSI junction	0.027	0.020	0.008	-31.1%	1.3	ns
Summer	0.257	0.299	0.311	-0.4%	0.1	ns
Winter	0.264	0.263	0.265	2.6%	1.1	ns

The observed accident rate for the bilingual routes after the installation of the signs were sometimes lower and sometimes higher than the 'before' rates. The ratio of the observed rates to the predicted rates (effect) for the 'after' period on bilingual routes indicates fairly small changes in almost all cases, and no changes were statistically significant.

Figure 4.4, shows the accident rate for all accidents (based on annual data) and indicates that the rate on bilingual routes after the installation of signs follows that observed on the comparison routes. The 'after' effect is not significant as seen in Table 4.17.

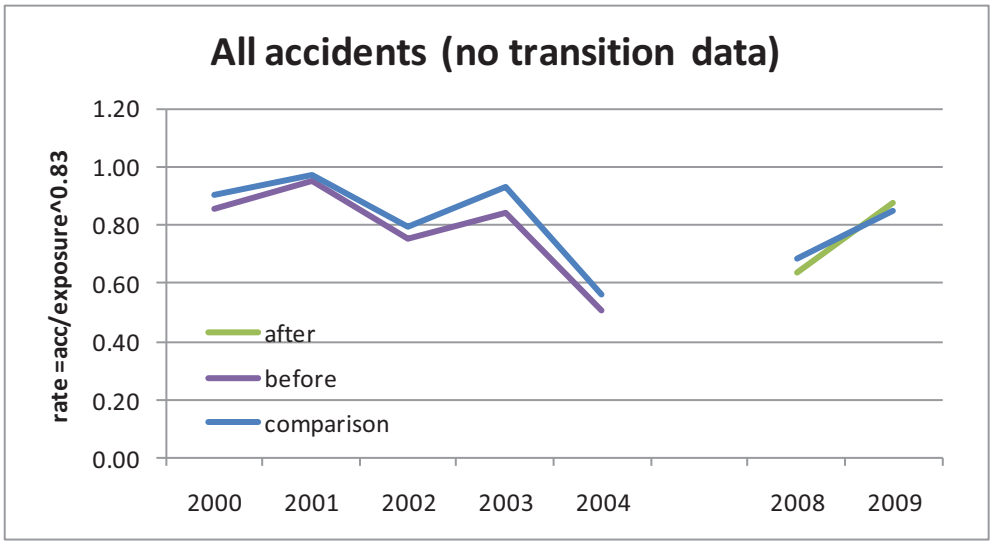


Figure 4.4: Accident rates for all accidents for periods where there either are or are not bilingual signs

The second approach taken was to run an analysis using all periods (other than when the month the bilingual sign was installed and a month either side), but with a more

complex model which included a factor for each individual route. This analysis meant that more data points could be included but required an additional parameter associated with each of the routes. The results are shown in Table 4.18. This extended model analysis on the entire data set did not find any statistically significant change in accident rates due to the installation of bilingual signs, and confirms the findings from the initial approach utilising the more parsimonious model.

Table 4.18: All months analysis of effect size with route factors included in the model

Accident type	Comparison	Bilingual				
		Before	After			
	Observed rate	Observed rate	Observed rate	Effect	Deviance	Significance
All	0.266	0.284	0.293	4.0%	1.2	ns
All KSI	0.090	0.106	0.075	3.0%	0.2	ns
Car	0.230	0.232	0.249	4.6%	1.3	ns
KSI car	0.074	0.082	0.059	5.0%	0.3	ns
PTW	0.074	0.082	0.059	4.5%	0.2	ns
PTW car	0.074	0.082	0.059	-3.5%	0.1	ns
Junction	0.092	0.059	0.047	5.8%	0.5	ns
KSI junction	0.027	0.020	0.008	-6.8%	0.2	ns
Summer	0.257	0.299	0.311	-1.4%	0.1	ns
Winter	0.257	0.299	0.311	8.4%	2.1	ns

4.5.4 Summary of combined route analysis

The use of generalised linear models facilitates controlling for seasonal effects, trend effects, exposure and any potential difference between the comparison routes and the bilingual routes; hence more of the variability in the accident data can be explained. The impact on accident rate at the introduction of bilingual signs can therefore, in theory, be better determined.

The initial analysis considered data from periods where there were no bilingual signs installed and where all bilingual signs had been installed, that is, without a transitional period during which signs were being installed on different routes at different rates. This analysis found no statistically significant changes in accident rates that could be attributed to the installation of bilingual signs. An extension to this approach which included a factor associated with each route used all data (other than around the installation month), and used the data from the transitional period during which signs were being installed on different routes at different times, also found that there were no statistically significant changes in accident rates associated with the installation of the bilingual signs.

4.6 Summary

Two types of analysis have been used to assess the difference in accident rates before and after the installation of bilingual signs.

The Hauer approach analysed individual routes and found that on some routes accident rates had risen more than would be expected after the bilingual signs had been installed. At other routes some accident rates had fallen more than expected (based on

comparison route data). No statistically significant changes were observed in KSI accidents or in accidents at junctions.

The modelling approach combined all the routes together. Once data from the transitional period (during which signs were being introduced on different sub-sets of routes at different rates) had been removed, no significant changes were found, suggesting that the overall accident rates before and after installation of the signs were similar to what would have been expected had the signs not been installed. An extended model, which included a factor associated with each route based on all period data, did not find any statistically significant change in accident rates on routes where bilingual signs were installed.

Overall, the picture provided by the accident analyses is reasonably consistent. Although there were mixed results in the Hauer analysis on individual routes (with some showing rises and some showing falls in accident rates associated with the bilingual signs), the modelling approach showed that there were no overall effects in either direction. Overall, it can be said that the analysis did not detect a consistent effect on accident rates, in either direction, of the installation of bilingual road signs.

The assumptions under which the analyses were carried out are also worthy of mention; it has been assumed that the routes on which bilingual signs were installed were directly comparable to the comparison routes. In some cases (e.g. traffic flow, speed limits) it was possible to check these assumptions as data were available on some variables. However there are a number of other factors for which data are not available or for which there was not time to explore in detail. For example, it is not clear if other engineering improvements or road safety interventions (e.g. enforcement), or other changes relating to risk (e.g. use of the route by a greater proportion of young and inexperienced drivers) accompanied the installation of bilingual signs. If they did, then any changes in accident rate that accompany the installation of the signs (for example some of the changes seen in the Hauer analysis) cannot be confidently ascribed to the signage itself.

5 Survey of Drivers

The aim of the survey activity in the project was to establish the attitudes held by drivers regarding bilingual signs in terms of their perceived impact on road safety, behavioural responses to the signs, and their aesthetic impacts. To achieve this aim a questionnaire was designed and was administered in April 2010 and June 2010 to three different groups of drivers in Scotland. The three groups were local drivers who read Gaelic, local drivers who did not read Gaelic, and tourists; the three groups will be referred to as 'Gaelic', 'Non-Gaelic', and 'Tourist' within the report.

5.1 Questionnaire design

The questionnaire was designed with the intention of it being able to:

- distinguish any difference between participants' self-reported behaviour and attitudes towards monolingual and bilingual road signs;
- establish general attitudes to road signs and bilingual road signs; and
- establish if drivers report any impact on road safety caused by bilingual road signs.

Copies of the questionnaires can be seen in Appendix C. Reverse order copies of these questionnaires were also created. The order of the monolingual and bilingual sign sections of the questionnaires was counterbalanced so as to negate any bias from answering either the monolingual or bilingual sign questions first/last.

During the early stages of the project, TRL researchers undertook a drive on trunk roads in Scotland on which bilingual signs had been installed. The purpose of the drive was to allow the researchers to gain an appreciation of the context of the signs and to record video and still images of the signs *in situ*. The images taken from this drive provided the opportunity to use real signs as illustrations and stimuli in the questionnaire. For the questionnaire, four pictures of bilingual road signs were selected including three advanced directional signs and one route confirmatory sign. To enable direct comparison of monolingual and bilingual road signs, copies of the bilingual signs were digitally altered to represent their monolingual equivalents (see Figure 5.1).

In the questionnaire, there were four key dependent measures. Three of these were measured by self-reported responses to four pairs of signs (monolingual and bilingual) that were accompanied with questions measuring each of the following:

1. Ease of finding information on the sign.
2. Speed choice on the road illustrated.
3. Ratings of aesthetic impact of the signs.

To measure the fourth dependent measure, people were asked to self-report the frequency with which they had experienced a number of behaviours in response to another pair of signs (similarly manipulated into monolingual and bilingual equivalents), as shown in Figure 5.2.

The pictures of monolingual and bilingual roads signs were separated by other sections of the questionnaire so that it was more difficult for respondents to make conscious and direct comparisons between the alternatives; instead we were interested in capturing as closely as possible the 'honest' and 'first impression' answers of respondents to the signs shown.

Other sections of the questionnaire gathered information on general demographic variables and more general attitudes to issues such as road signs generally, and propensity to speed.

Figure 5.1: Monolingual and bilingual sign pairs used in the survey questionnaire (bilingual sign picture on left of each pair, and digitally altered image depicting monolingual equivalent on right)

Figure 5.2: Pair of signs use to elicit self-reported frequencies of specific behaviours

5.2 Survey fieldwork design

The aim of the fieldwork was to achieve completed questionnaires from 450 respondents, comprising 150 visitors and tourists to the survey locations (including visitors from overseas), and 300 local residents (split equally into those who can read Gaelic and those who cannot).

Potential respondents were approached and asked a series of filter questions. First they were asked whether they were a visitor to the area. A visitor was defined as someone who lived outside of the area encompassed by the bilingual signs network. For practical purposes, a person resident in Scotland, but living to the south or east of the network (e.g. Glasgow, the Borders, or Perth) would be categorised as a visitor, as would someone visiting from another country (including England and Wales). If the respondent fell into this category, they were then asked if they were currently driving on the roads in the area of the survey location. If the answer was yes, they were asked if they would like to take part in the survey. If not, they were thanked and the interviewer moved on to the next potential respondent.

If a potential respondent was not a visitor to the area, they were asked the following three questions:

1. Do you hold a valid UK driving licence?
2. Do you drive regularly locally?
3. Can you read Gaelic?

If the answer was no to either of the first two questions, the interview was halted, the respondent thanked and the interviewer moved on. The third question was asked only if the answers to both of the first two questions were yes. People were asked to take part whatever their answer to the third question, as this was simply used for auditing purposes to ensure that numbers of Gaelic, Non-Gaelic, and Tourist respondents was matched as close as possible to the intended sample size.

The fieldwork was conducted in two phases:

1. Phase 1, which took place 8th–11th April 2010
2. Phase 2, which took place 13th–19th June 2010

5.2.1 Phase 1

Two teams of interviewers were utilised. Team 1 concentrated on towns in the south of the area of interest: Oban, Fort William, Mallaig, and Tyndrum. Team 2 conducted interviews in Inverness and Ullapool in the north. Permissions to conduct the survey in each location were sought from Area Corporate Managers in the relevant local authorities who then passed on this information to the relevant community councils; the local police were also notified in advance. Once in the location, interviewers approached potential respondents in town centres, and in the vicinity of Tourist Information Centres. The survey was timed to coincide with the beginning of the tourist season, immediately after Easter.

5.2.2 Phase 2

The intention in Phase 2 was to gather completed interviews from Gaelic residents, given the relative lack of these respondents in Phase 1. In order to increase the probability of finding respondents that were able to read Gaelic, the survey locations were concentrated in those areas known to have a presence of Gaelic speakers. One team of interviewers visited Ullapool, Stornoway, Oban, Mallaig, and the Fort William area.

Permissions were again sought from the Area Corporate Managers, and the local police were notified in advance. In addition it was planned that the survey be conducted in car parks of ferry terminals to further increase the chances of finding Gaelic residents returning to their home on Scottish islands. Permissions were therefore obtained from either the relevant Harbour Authority or Ferry Terminal Managers in each location.

When conducting interviews at the ferry terminals, the interviewers abided by the instructions of terminal staff. The interviewers approached drivers of cars waiting in line for particular ferries and asked whether the potential respondent was a resident in the area and whether they were able to read Gaelic. Care was taken to ensure that the respondent understood that the interviewer had no connection with the ferry company, and was under no obligation to take part.

In town centres, passers-by were approached and asked if they could read Gaelic, and if so, whether they had driven on the mainland in the last year (for residents in Stornoway) or whether they could drive (for all other locations). They were then asked if they would take part in the survey.

Very few eligible respondents were found in Fort William town centre. Conversations with local police officers indicated that the nearby town of Caol has a Gaelic speaking population, and permission was sought from the local authority to continue the survey in that location.

Appendix D has details of all survey locations and a note of all respondents approached in the different locations during phase 2.

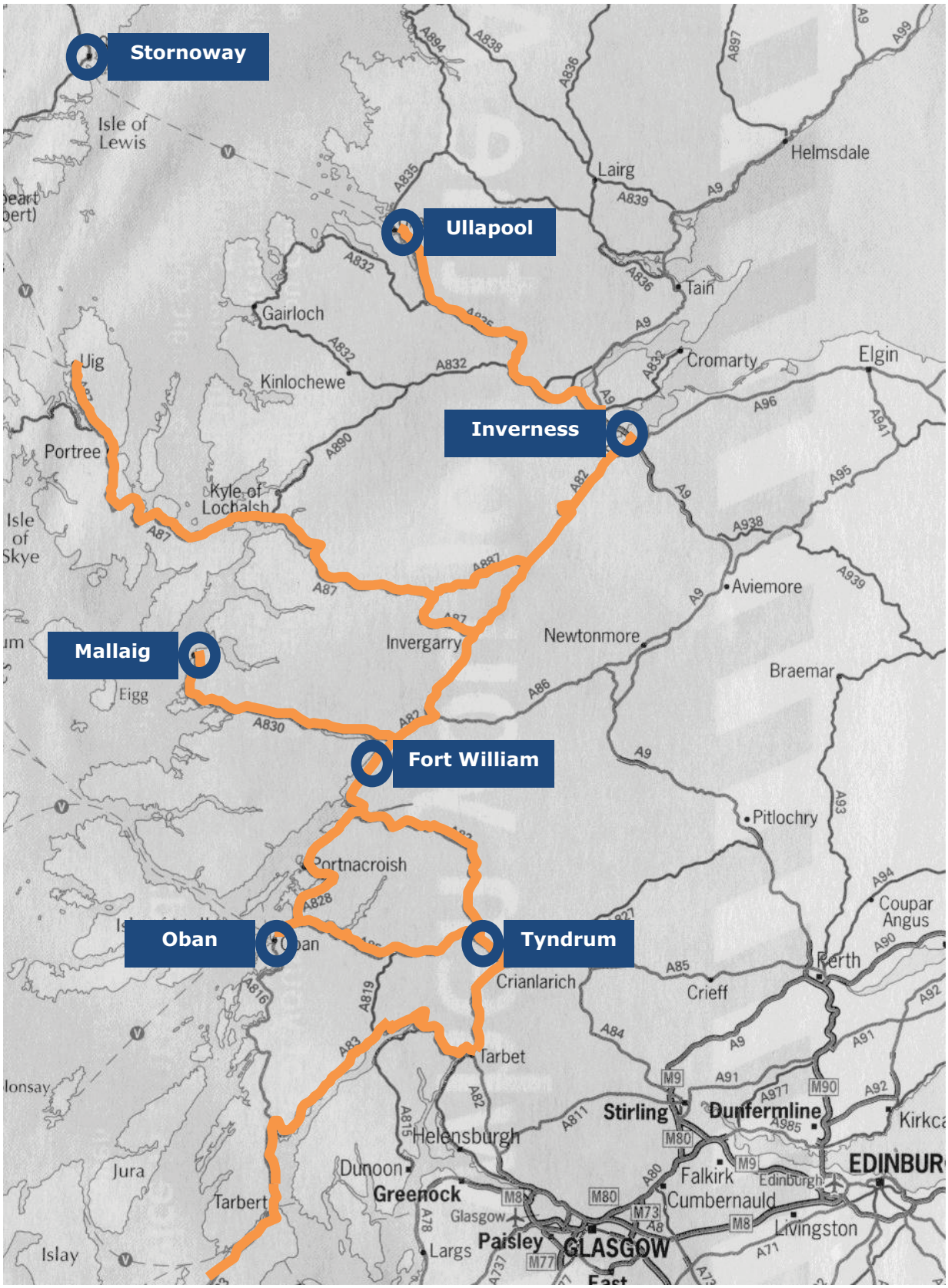


Figure 5.3: Map showing trunk roads with bilingual signs and TRL survey locations

5.3 Survey participants

In total, responses from 440 participants were achieved, which included 163 tourist questionnaires and 277 resident questionnaires. Of the residents, 101 respondents declared that they could read Gaelic and 176 reported that they could not. The sample size for the Gaelic group is therefore smaller than intended (101 versus 150); however in the experience of the project team this sample size is still sufficient to detect changes in the various behaviours and attitudes measured using questionnaire materials of the sort employed in this study. The three groups defined as Tourist, Gaelic and Non-Gaelic were also used for analysis and are referred to within the results section.

Demographically, the Gaelic respondents were statistically significantly older than the other two groups and there was a significantly higher proportion of males in the Tourist sample than the other two groups.

The Tourist group had different driving characteristics to the resident groups including a higher proportion with penalty points on their driving licence, a higher probability of using Satellite Navigation equipment and a higher mean annual mileage. There were no differences detected between Gaelic and Non-Gaelic groups on these variables. The Tourist group was also shown to have different 'general' attitudes to road signs than the residents.

In order that the results for the different groups are comparable, the groups need to be as demographically similar as possible. Weights were applied to the Gaelic group to match age distributions to the other groups, and to the Tourist group to match the distribution of sexes to the other groups. This ensures that any differences between the groups that are due to age and gender have been accounted for in the analysis.

Unless otherwise stated, where descriptive data are presented these are shown as un-weighted numbers, and where tests have been completed, these have been done on the weighted data.

The number of accidents reported by the three groups was not different. The respondents in the Gaelic group were more likely to speed (as measured by the general speed propensity items). However no matching on this variable was carried out, since the key comparison relating to the effects of bilingual signs on speed was concerned with relative speed choice to the monolingual and bilingual signs, and not absolute values.

5.4 Results

The results are reported in this section in summary format. A full technical description of the analyses and findings can be found in Appendix E.

The survey was designed with the intention of answering four main research questions:

1. Do monolingual and bilingual signs differ with respect to the ease with which drivers feel they can locate information (and is this different for the different groups of drivers tested)?
2. Do monolingual and bilingual signs elicit different self-rated speed choice (and is this different for the different groups of drivers tested)?
3. Do monolingual and bilingual signs lead to different ratings of attractiveness of otherwise identical road scenes (and is this different for the different groups of drivers tested)?
4. Do monolingual and bilingual signs lead to different self-ratings of safety impact (and is this different for the different groups of drivers tested)?

For each of the first three research questions, the four different monolingual and bilingual sign pairs (three advanced directional sign pairs and one route confirmatory sign pair) were analysed separately. The fourth question was answered with respect to a single monolingual and bilingual sign pair.

5.4.1 Do monolingual and bilingual signs differ with respect to the ease with which drivers feel they can locate information (and is this different for the different groups of drivers tested)?

The first question asked the respondents to rate the ease with which they could find the required information on the monolingual and bilingual versions of each of the four signs. The scale ranged from 1 (not easily) to 7 (very easily). Comparisons were then made within each of the three groups comparing the results for each monolingual and bilingual sign. The difference between the score for each monolingual and bilingual sign was calculated for each person. These difference scores were then compared to see if there was a statistically significant difference between the Gaelic and Non-Gaelic groups.

5.4.1.1 *Non-Gaelic respondents*

Table 5.1 shows the percentages of Non-Gaelic respondents who rated the monolingual sign as easier to find information on than its bilingual equivalent; the percentage who rated the bilingual sign as easier; and the percentage who rated that there was no difference in the ease at which information could be found. For each of the four signs, the majority of Non-Gaelic respondents found it easier to find information on the monolingual sign than the bilingual equivalent.

Table 5.1: Data from ratings of 'ease of finding information' for Non-Gaelic respondents[9]

	Percentages of Non-Gaelic respondents finding:		
	Monolingual sign easier	**No difference**	**Bilingual sign easier**
Sign 1	65%	25%	10%
Sign 2	76%	18%	6%
Sign 3	73%	23%	4%
Sign 4	76%	22%	3%

A Wilcoxon matched-pairs signed-ranks test[10] on the weighted data showed that for all four signs, Non-Gaelic participants rated the monolingual sign as significantly easier to find information on than the Bilingual equivalent ($p<0.01$).

5.4.1.2 *Gaelic respondents*

The 'ease of finding information' data for Gaelic respondents are displayed in Table 5.2. For each sign, the majority of the Gaelic group report no difference in the ease at which information was found. However, it is still the case that a greater number of respondents rated that it was easier to find information on the monolingual sign than the bilingual sign.

[9] Note that in all tables, percentages do not always add up to 100 due to rounding.

[10] This non-parametric test treats data as ranked and does not make any parametric assumptions about the distribution of scores. More detail on the treatment of the data can be found in Appendix E, but the important point here is that the use of this particular test is suitable for these kinds of data, when parametric assumptions cannot be made. From this point in the report, for brevity, this test is referred to simply as a 'Wilcoxon' test.

Table 5.2: Data from ratings of 'ease of finding information' for Gaelic respondents

	Percentages of Gaelic respondents finding:		
	Monolingual sign easier	**No difference**	**Bilingual sign easier**
Sign 1	25%	67%	8%
Sign 2	45%	46%	10%
Sign 3	42%	54%	4%
Sign 4	37%	60%	3%

A Wilcoxon test on the weighted data showed that for all four signs, Gaelic participants overall rated the monolingual sign as significantly easier to find information on than the bilingual equivalent ($p<0.01$).

5.4.1.3 *Comparing Non-Gaelic and Gaelic groups*

Changes in 'ease of information' ratings given to the monolingual and corresponding bilingual signs were calculated by subtracting the score given for the bilingual sign from the score for the monolingual sign for each participant in each of the Gaelic and Non-Gaelic groups. This difference score reflects the extent to which Gaelic and Non-Gaelic respondents 'favour' one sign type or the other (in terms of ease of finding information) and we can use this score to test whether there is a difference in the extent to which Gaelic and Non-Gaelic respondents favour each sign type.

A Mann-Whitney test[11] showed that for all four signs, although both groups gave higher 'ease of finding information' ratings to the monolingual equivalent, the extent to which monolingual signs were preferred was greater for Non-Gaelic respondents ($p<0.01$).

5.4.1.4 *Tourist respondents*

The 'ease of finding information' data for Gaelic respondents are displayed in Table 5.3. For each of the four signs, the majority of Tourist respondents found it easier to find information on the monolingual sign than the bilingual equivalent.

[11] This test is appropriate when testing for statistically significant differences between the scores of two separate groups of respondents (in this case the difference in Gaelic and Non-Gaelic respondents' ratings to monolingual and bilingual signs for ease of finding information).

Table 5.3: Data from ratings of 'ease of finding information' for Tourist respondents

	Percentages of Tourist respondents finding:		
	Monolingual sign easier	**No difference**	**Bilingual sign easier**
Sign 1	71%	24%	5%
Sign 2	77%	17%	6%
Sign 3	78%	18%	4%
Sign 4	74%	22%	4%

A Wilcoxon test on the weighted data showed that for all four signs, Tourist respondents overall rated the monolingual sign as significantly easier to find information on than the Bilingual equivalent ($p<0.01$).

5.4.1.5 *Summary of 'ease of finding information' results*

All three groups of respondents rated the monolingual signs as 'easier to find information on' and this was true for all the sign pairs tested. The extent to which monolingual signs are preferred in this respect was greatest for Tourist respondents and greater for Non-Gaelic than for Gaelic resident respondents.

5.4.2 Do monolingual and bilingual signs elicit different self-rated speed choice (and is this different for the different groups of drivers tested)?

The next comparison question asked respondents to report the speed at which they would travel along the section of road depicted in each picture. The speeds for the monolingual and bilingual sign scenes were compared within the three groups and then the differences in how the speed ratings changed from the monolingual to bilingual sign scenes were examined for the Gaelic and Non-Gaelic groups.

5.4.2.1 *Non-Gaelic respondents*

Table 5.4 shows the self-reported speeds (in mph) for each of the monolingual and bilingual signs by the Non-Gaelic group.

Table 5.4: Self-reported speed data for Non-Gaelic respondents

	Monolingual sign		Bilingual sign		
	Median (mph)	**Inter-quartile Range (mph)**	**Median (mph)**	**Inter-quartile Range (mph)**	**Proportion of group which report different speeds for the monolingual and bilingual sign**
Sign 1	50	20.0	45	11.3	49%
Sign 2	20	20.0	20	15.0	40%
Sign 3	50	20.0	50	20.0	50%
Sign 4	50	20.0	50	16.3	43%

A Wilcoxon test on the weighted data showed that for signs 1 and 4, Non-Gaelic respondents gave self-reported speeds to the monolingual sign scene that were significantly higher than the self-reported speeds given to the bilingual sign scene ($p<0.01$)[12]. The self-reported speeds reported for signs 2 and 3 showed no significant difference.

5.4.2.2 *Gaelic respondents*

The Gaelic group's self-reported speeds for monolingual and bilingual signs are shown in Table 5.5.

Table 5.5: Self-reported speed data for Gaelic respondents

	Monolingual sign		Bilingual sign		
	Median (mph)	**Inter-quartile Range (mph)**	**Median (mph)**	**Inter-quartile Range (mph)**	**Proportion of group which report different speeds for the monolingual and bilingual sign**
Sign 1	50	15.0	45	15.0	33%
Sign 2	30	5.0	30	7.5	32%
Sign 3	50	20.0	50	20.0	39%
Sign 4	50	15.0	50	15.0	31%

A Wilcoxon test on the weighted data showed that for signs 2 and 4, Gaelic respondents gave self-reported speeds to the monolingual sign scene that were significantly higher than the self-reported speeds given to the bilingual sign scene ($p<0.05$). The self-reported speeds reported for signs 1 and 3 showed no significant difference.

5.4.2.3 *Comparing Gaelic and Non-Gaelic groups*

Changes in self-reported speeds given to the monolingual and corresponding bilingual signs were calculated by subtracting the speed given for the bilingual sign from the score for the monolingual sign for each participant in each of the Gaelic and Non-Gaelic groups. This difference score reflects the extent to which Gaelic and Non-Gaelic respondents give higher self-reported speeds to the monolingual or bilingual signs.

A Mann-Whitney test showed that for sign 1 there is a significant difference ($p<0.01$) in the self-reported speed ratings for the Gaelic and Non-Gaelic groups. Similarly, there is a significant difference ($p<0.05$) between the groups for sign 4. For both of these sign pairs, Non-Gaelic respondents showed a greater reduction in speed with the bilingual sign than did Gaelic respondents. For sign pairs 3 and 4, there is no significant difference in the change in speed between the monolingual and bilingual sign for the Gaelic and Non-Gaelic group, that is, the Gaelic and Non-Gaelic group change their ratings in similar ways.

[12] It should be noted that the Wilcoxon test takes the difference between pairs of data points and ranks the magnitude of those differences to assess whether distributions of scores are likely to be significantly different. In practice this can mean that medians (literally the middle score), even though they are the same, still come from distributions of scores that differ significantly from one-another (i.e. these are the statistically significant findings).

5.4.2.4 *Tourist respondents*

Table 5.6 displays the self-reported speeds by the Tourist group for monolingual and bilingual signs.

Table 5.6: Self-reported speed data for Tourist respondents

	Monolingual signs		Bilingual signs		
	Median (mph)	**Inter-quartile Range (mph)**	**Median (mph)**	**Inter-quartile Range (mph)**	**Proportion of group which report different speeds for the monolingual and bilingual sign**
Sign 1	45	12.5	40	20.0	52%
Sign 2	20	15.0	20	15.0	52%
Sign 3	50	20.0	45	17.5	54%
Sign 4	50	15.0	40	15.0	55%

A Wilcoxon test on the weighted data showed that for all four signs the self-reported speeds were significantly higher for monolingual signs than for bilingual signs ($p<0.01$).

5.4.2.5 *Summary of self-rated speed data*

The Gaelic and Non-Gaelic groups reported slower speeds in response to the bilingual signs compared to the monolingual signs for two of the four sets of signs. This suggests that factors within the context of the signs may be important determinants of driver speed choice. However, Tourists' reported speeds were significantly slower for the bilingual signs for all sets of signs which suggests that sign comprehension (or size) was an important determinant in their choice of speed. Comparison of Gaelic and Non-Gaelic groups suggests that Non-Gaelic respondents show a greater speed reduction on two of the signs than did Gaelic respondents.

5.4.3 Do monolingual and bilingual signs lead to different ratings of attractiveness of otherwise identical road scenes (and is this different for the different groups of drivers tested)?

The third comparison question for each set of monolingual and bilingual sign asked the respondents to rate whether they thought the sign made the scene more or less attractive. The scale ranged from -3 (less) to 3 (more). Comparisons were made within the three groups between the ratings for the monolingual and bilingual sign. Finally, the difference between each person's score for the monolingual and bilingual sign was calculated and a Mann Whitney test was carried out to test for significant differences between the Gaelic and Non-Gaelic groups.

5.4.3.1 *Non-Gaelic respondents*

Table 5.7 displays the proportion of Non-Gaelic respondents who rated the monolingual sign as making the scene more attractive than the bilingual sign; the bilingual sign as making the scene more attractive than the monolingual sign; and no difference in the attractiveness of the two scenes. Similar proportions of this group rated the monolingual sign as more attractive and reported no difference in the attractiveness of the scene for all four of the signs.

Table 5.7: Attractiveness data for Non-Gaelic respondents

	Percentage of Non-Gaelic respondents finding:		
	Monolingual sign makes scene more attractive	**No difference between monolingual and bilingual sign**	**Bilingual sign makes scene more attractive**
Sign 1	43%	48%	9%
Sign 2	49%	44%	7%
Sign 3	48%	47%	5%
Sign 4	49%	45%	6%

A Wilcoxon test on the weighted data showed that for all four signs, Non-Gaelic respondents rated the monolingual sign as significantly more 'attractive' than to the bilingual sign ($p<0.01$).

5.4.3.2 *Gaelic respondents*

Table 5.8 displays the attractiveness rating data for Gaelic respondents. The majority of the Gaelic group report no difference in the attractiveness of the two scenes.

Table 5.8: Attractiveness data for Gaelic respondents

	Percentage of Gaelic respondents finding:		
	Monolingual sign makes scene more attractive	**No difference between monolingual and bilingual**	**Bilingual sign makes scene more attractive**
Sign 1	18%	62%	20%
Sign 2	17%	71%	12%
Sign 3	18%	70%	12%
Sign 4	14%	71%	15%

A Wilcoxon test on the weighted data showed that for all four signs, the attractiveness ratings given to monolingual and bilingual signs by Gaelic respondents did not differ (p=ns).

5.4.3.3 *Comparing Gaelic and Non-Gaelic groups*

Changes in 'attractiveness' ratings given to the monolingual and corresponding bilingual signs were calculated by subtracting the score given for the bilingual sign from the score for the monolingual sign for each participant in each of the Gaelic and Non-Gaelic groups. This difference score reflects the extent to which Gaelic and Non-Gaelic respondents 'favour' one sign type or the other (in terms of attractiveness) and we can use this score to test whether there is a difference in the extent to which Gaelic and Non-Gaelic respondents favour each sign type.

The analyses reported in this section showed that the Gaelic respondents showed no significant difference in their ratings of attractiveness for the monolingual and bilingual sign; in most cases the Gaelic respondents find neither sign more attractive than the

other. The Non-Gaelic group on the other hand gave significantly higher attractiveness ratings to the monolingual signs.

A Mann-Whitney test on difference scores confirmed this pattern of results; Non-Gaelic respondents tended to show a higher rating for monolingual signs and this differed significantly from that of Gaelic respondents (all $p<0.01$).

5.4.3.4 *Tourist respondents*

The Tourist data for attractiveness are shown in Table 5.9. Similar proportions rated the monolingual sign as more attractive than the bilingual and report no difference in the attractiveness of the scene; overall the data look very similar to those gathered from the Non-Gaelic respondents.

Table 5.9: Attractiveness data for Tourist respondents

	Percentage of Tourist respondents finding:		
	Monolingual sign makes scene more attractive	**No difference between monolingual and bilingual sign**	**Bilingual sign makes scene more attractive**
Sign 1	46%	49%	6%
Sign 2	49%	46%	6%
Sign 3	48%	46%	7%
Sign 4	45%	48%	7%

A Wilcoxon test on the weighted data showed that for all four signs, Tourist respondents gave significantly higher 'attractiveness' ratings to the monolingual sign than to the bilingual sign ($p<0.01$).

5.4.3.5 *Summary of attractiveness data*

The attractiveness data show that the Non-Gaelic residents and the Tourists rated monolingual signs as relatively more attractive than bilingual signs in terms of how they add to or detract from the attractiveness of the road scenes tested. The Gaelic respondents gave equal ratings to the monolingual and bilingual signs in this respect.

5.4.4 Do monolingual and bilingual signs lead to different self-reported behaviours (and is this different for the different groups of drivers tested)?

Respondents were asked to answer 'yes' or 'no' to each of the following statements, based on whether or not the behaviour described applied to them in relation to either a bilingual or monolingual sign:

1. I find it difficult to find the information I am looking for on signs like these
2. I have had to slow down to read signs like these
3. I have had to stop the car to read signs like these
4. I have taken a wrong turn because of signs like these
5. I have been distracted when driving because of signs like these
6. I had a 'near miss' because of signs like these
7. I have been involved in an accident because of signs like these

The behaviours can be characterised as relating to 'finding information' (1), relating to 'speed changes' (2 and 3), relating to 'distraction and misunderstanding' (4 and 5) and being 'directly safety-related' (6 and 7). The key comparison of interest for each of these questions (and for each of the three respondent groups) was whether people reported the specific behaviours in relation to the bilingual signs more often than for monolingual signs, or vice-versa.

Section E.6 in Appendix E shows the number of respondents in each group who answered 'yes' or 'no' to each individual behavioural question for both the bilingual and monolingual sign. However in this section we report only the percentage of respondents who answered 'yes' to the bilingual sign but 'no' to the monolingual sign (and vice-versa); these two figures tell us whether people differed in their responses in relation to the bilingual or monolingual signs.

5.4.4.1 *Non-Gaelic respondents*

Table 5.10 shows the data for Non-Gaelic respondents. The data reveal a clear tendency towards reporting difficulty of finding information, slowing down and stopping, taking wrong turns and being distracted in relation to bilingual signs, more often than monolingual signs. All of these differences are statistically significant (although larger in magnitude for difficulty of finding information, slowing down, and being distracted).

Table 5.10: Self-reported behavioural responses to monolingual and bilingual signs: Non-Gaelic respondents

	Percentage of respondents who reported:			
	'Yes' to bilingual and 'no' to monolingual	**'Yes' to monolingual and 'no' to bilingual**	**Valid N**	**Significant difference?**
1. I find it difficult to find the information I am looking for on signs like these	47%	0%	176	p<0.01
2. I have had to slow down to read signs like these	42%	1%	176	p<0.01
3. I have had to stop the car to read signs like these	10%	0%	176	p<0.01
4. I have taken a wrong turn because of signs like these	18%	2%	176	p<0.01
5. I have been distracted when driving because of signs like these	40%	1%	176	p<0.01
6. I had a 'near miss' because of signs like these	5%	1%	176	ns
7. I have been involved in an accident because of signs like these	N/A[13]	N/A		

[13] In the entire sample of respondents (all three groups) only two people reported having collisions due to signs of any type (one Non-Gaelic resident respondent and one Tourist, both in relation to bilingual signs). These numbers are far too small to be considered for any kind of statistical analysis.

5.4.4.2 *Gaelic respondents*

Table 5.11 reports data for the Gaelic respondents, and shows that this group were much less likely to report a major difference in the various behaviours for bilingual over monolingual signs (although in all cases, even the non-significant ones, the difference is in this direction). The only statistically significant differences are for the difficulty of finding information, and the 'stopping to read signs like these' behaviours.

Table 5.11: Self-reported behavioural responses to monolingual and bilingual signs: Gaelic respondents

	Percentage of respondents who reported:			
	'Yes' to bilingual and 'no' to monolingual	**'Yes' to monolingual and 'no' to bilingual**	**Valid N**	**Significant difference?**
1. I find it difficult to find the information I am looking for on signs like these	17%	1%	101	p<0.01
2. I have had to slow down to read signs like these	7%	4%	101	ns
3. I have had to stop the car to read signs like these	8%	1%	101	p<0.05
4. I have taken a wrong turn because of signs like these	9%	7%	101	ns
5. I have been distracted when driving because of signs like these	15%	6%	100	ns
6. I had a 'near miss' because of signs like these	4%	1%	101	ns
7. I have been involved in an accident because of signs like these	N/A	N/A		

5.4.4.3 *Tourist respondents*

Table 5.12 shows the data for Tourist respondents. The pattern of findings is broadly similar as for the Non-Gaelic resident respondents. However in addition, 6% of Tourists mention that they have had a 'near miss' due to a bilingual sign (but not a monolingual one), and this is significantly higher than the percentage of Tourists who show the reverse pattern.

Table 5.12: Self-reported behavioural responses to monolingual and bilingual signs: Tourist respondents

	Percentage of respondents who reported:			
	'Yes' to bilingual and 'no' to monolingual	**'Yes' to monolingual and 'no' to bilingual**	**Valid N**	**Significant difference?**
1. I find it difficult to find the information I am looking for on signs like these	49%	1%	162	p<0.01
2. I have had to slow down to read signs like these	46%	2%	163	p<0.01
3. I have had to stop the car to read signs like these	19%	1%	162	p<0.01
4. I have taken a wrong turn because of signs like these	19%	1%	162	p<0.01
5. I have been distracted when driving because of signs like these	44%	2%	162	p<0.01
6. I had a 'near miss' because of signs like these	6%	1%	159	p<0.05
7. I have been involved in an accident because of signs like these	N/A	N/A		

5.4.4.4 *Summary of self-reported behavioural data*

The data on self-reported behaviours broadly follow the pattern of the questions relating to ease of finding information, speed ratings, and attractiveness data; Non-Gaelic residents and Tourists in general are more likely to report 'issues' specifically related to their encounters with bilingual signs (especially in terms of difficulty finding information, slowing down and sometimes stopping to read the signs, and being distracted and taking wrong turns). Gaelic residents on the other hand have less of a tendency to report behaviours specifically in relation to bilingual signs when compared to monolingual signs.

5.4.5 Additional questions

The survey included some additional items, which are reported in this section.

5.4.5.1 *"The presence of Gaelic makes it difficult to read the English on signs like these"*

Table 5.13 shows the percentage of Gaelic, Non-Gaelic and Tourist respondents who responded 'yes' and 'no' to the statement 'the presence of Gaelic makes it difficult for me to read the English on signs like these'. The clear pattern in the data is that Non-Gaelic and Tourist respondents tended to agree with this statement, while Gaelic respondents tended to disagree.

Table 5.13: Percentage of each group responding 'yes' or 'no' to the statement 'the presence of Gaelic makes it difficult for me to read the English on signs like these'

Presence of Gaelic makes it difficult to read English?	Non-Gaelic	Gaelic	Tourist
Yes	75%	20%	76%
No	25%	80%	24%

5.4.5.2 *"The presence of English makes it difficult to read Gaelic on signs like these"*

The percentage of each group who responded 'yes' and 'no' to the statement 'the presence of English makes it difficult for me to read the Gaelic on signs like these' is shown for the Gaelic, Non-Gaelic and Tourist groups in Table 5.14. All of the Non-Gaelic group, and all but one person in the Tourist group responded 'no' to this statement, which would be expected given that these groups do not read (at least to understand) Gaelic anyway. Only a very small proportion (9%) of the Gaelic group reported that the English text made reading the Gaelic text difficult.

Table 5.14: Proportion of each group which responds 'yes' or 'no' to the statement 'the presence of English makes it difficult for me to read the Gaelic on signs like these'

Presence of English makes it difficult to read Gaelic?	Non-Gaelic	Gaelic	Tourist
Yes	0%	9%	1%
No	100%	91%	99%

5.4.5.3 *Do you read English or Gaelic directions, or both, when driving?*

The participants were also asked whether they read the English directions, Gaelic directions or both when driving. For both the Non-Gaelic and Tourist groups nearly everyone said that they read only the English part of the sign; a very small minority said they read both. In the Gaelic group however, the majority responded that they read both, 32% said they read the English only and 7% said they read only the Gaelic.

5.5 Summary

The survey was designed with the intention of answering four main research questions:

1. Do monolingual and bilingual signs differ with respect to the ease with which drivers feel they can locate information (and is this different for the different groups of drivers tested)?
2. Do monolingual and bilingual signs elicit different self-rated speed choice (and is this different for the different groups of drivers tested)?
3. Do monolingual and bilingual signs lead to different ratings of attractiveness of otherwise identical road scenes (and is this different for the different groups of drivers tested)?
4. Do monolingual and bilingual signs lead to different self-ratings of safety impact (and is this different for the different groups of drivers tested)?

To answer question 1, all groups' responses were analysed separately and responses from the Gaelic and Non-Gaelic groups were directly compared. Results suggest that overall, all groups find it easier to locate information on the monolingual signs compared with finding information on the bilingual signs. However while the majority of the Non-Gaelic and Tourist groups reported the monolingual signs as easier to locate information on, the majority of the Gaelic group were indifferent, suggesting that many of them found it just as easy to locate information on both types of signs.

For question 2, drivers' stated speeds for the matched pictures of monolingual and bilingual signs were analysed. Results found that all groups of drivers reported significantly slower speeds to at least two of the four bilingual signs compared to their monolingual equivalent. Tourists' stated speeds for all bilingual signs were significantly slower when compared with the monolingual signs. Non-Gaelic respondents' stated speeds were slower for two of the bilingual signs when compared with monolingual equivalents, and this difference was greater than that reported by Gaelic respondents.

Data for question 3 were analysed in the same way as for question 1. Analysis of the attractiveness data determined that Non-Gaelic and Tourist drivers found that the scenes with monolingual signs were significantly more attractive than the scenes with the bilingual signs. Gaelic respondents did not find the scenes with either sign more or less attractive.

Analysis of self-reported behaviours in response to the signs found that all driver groups reported finding it more difficult to locate information on bilingual signs compared to monolingual signs, and also that they were more likely to have had to stop to read bilingual signs compared to monolingual signs. While the Gaelic group did not report any further behaviour specific to the different signs, both the Non-Gaelic and Tourist groups reported having had to slow down for bilingual signs, having taken a wrong turn because of bilingual signs, and having been distracted because of bilingual signs. Only the Tourist group reported that they were more likely to have had a 'near miss' because of bilingual signs when compared with monolingual signs.

6 Interviews with Local Authorities

The aim of the local authority interviews was to obtain their views on the impact of bilingual signs on road safety, including what, if any, evidence they were using to form their opinion. We also sought to determine what other factors they deemed relevant in considering whether bilingual signs should be installed in their area. The six local authorities interviewed were:

- Aberdeenshire
- Argyll and Bute
- Highland
- Perth and Kinross
- Stirling
- Fife

These were identified by Transport Scotland to represent both areas with a strong Gaelic language tradition, and areas with less Gaelic heritage.

Letters were initially sent to the Chief Executive of each local authority, who then decided who would represent the authority. In all cases the interviewees were officers of the local authority who had some responsibility for roads. Interviews took place in October 2009 and January 2010.

The discussions were unstructured to allow the representatives to cover whatever topics they saw as pertinent, but included prompts on the following topics:

- Tourism
- Impact on local residents
- Cultural heritage
- The aesthetic environment
- Financial implications

The interviews were analysed for emergent themes that were relevant to the research.

6.1 Relevance

The perceived relevance of the Gaelic language was found to vary with location; it is seen as more relevant in the north-west than in more easterly or southern areas which do not have the same level of Gaelic heritage. The areas covered by Fife, Stirling and Aberdeenshire authorities were not reported as having a Gaelic heritage. Within Argyll and Bute, Highland, and Perth and Kinross there were areas where there was a tradition of Gaelic speaking; the strength of this tradition varied geographically within the local authority area. These differences were reflected in the extent to which the different local authorities were promoting the Gaelic language (e.g. in schools and on signage generally) and whether they are working in support of a Gaelic language plan.

Where there was a Gaelic heritage in the area, local authorities saw a role for bilingual signs in supporting and promoting that heritage. There were differing views expressed, however, about using Gaelic road signs as a means of increasing awareness of and supporting the Gaelic language. Some felt it was an appropriate way to support the language, whilst others felt that the role of road signs was primarily functional and thought that there were other ways of supporting Gaelic that were more appropriate (such as through education in schools and media).

In two local authorities the officers interviewed reported that Polish might be considered more relevant than Gaelic, based on the higher proportion of Polish speakers in their area than Gaelic speakers. The introduction of bilingual signs could conceivably lead to

demands for further languages to be included based on the current prevalence of the language in the area. It was also noted that Scotland has other indigenous languages/dialects, including Doric, but that there was no evidence of a desire to include these on road signs.

6.2 Sign replacement

Two of the local authorities interviewed had experience of replacing monolingual road signs with bilingual road signs on the local road network. It was stated that the replacement program for some sections required existing signs to be replaced only through wear and tear rather than introducing them along an entire route at one time. This had raised some concerns about the implications of inconsistent signing, which might be confusing for drivers. An interviewee noted that signs typically last around 20 years, so the inconsistent signing would be a long term issue. They also estimated the cost of a wholesale replacement exercise as running into seven figures, and that it was therefore inconceivable that the local authority would be able to fund this without help from central Government.

In the areas where bilingual signs were introduced, decisions had been required about whether both languages were needed, where place names were very similar, and if only one language was to be used then whether that would be English or Gaelic. It was noted in one interview that many places did not have an original Gaelic name, and that in these cases the local authority's decision was not to translate the names into Gaelic.

6.3 Financial implications

The financial implications of introducing bilingual signs were mentioned by all the local authorities. Most of them felt that the public would far prefer money to be spent on road maintenance, with potholes being frequently mentioned (this emerged in interviews held prior to the severe winter of 2009/10 and those afterwards). Value for money and public perception of value for money were both seen as very important. One interviewee reported that if bilingual signs were planned in their area "the postbag would be full". Several of those interviewed recognised that the increased size of the signs would increase the individual cost of a sign because of increased materials cost, possible requirement for site purchase and, where necessary, new passive safe posts (which reduce risk of personal injury if vehicles collide with the signs).

One local authority had carried out a consultation with the community councils in their area concerning bilingual signage. The primary concerns raised by the consultation were whether bilingual signs would distract drivers, whether maintenance of a larger sign would have cost implications and whether there would be a tourist benefit. A large majority of the community councils rejected the idea of introducing bilingual signage. The main reasons for rejection were related to cost.

6.4 Road safety

None of the local authorities reported having any evidence on the road safety implications of introducing bilingual signs. Several comments, for example that their existence in Wales "didn't seem to be a problem", indicated a perception and assumption that there had been more research into the safety implications than is in fact the case. All of the local authorities, including those who were most committed to bilingual signs, reported that they would re-visit the issue if there was evidence of a road safety problem associated with the signs.

Several of the interviewees commented that the result of introducing bilingual signs, both in increased sign size and in some cases an increased number of signs, was contrary to the Scottish Government's policy of reducing sign clutter.

6.5 Tourism

Promoting tourism in their area is a consideration for local authorities, and several interviewees recognised that the presence of bilingual signs might "give a feeling of being in Scotland" and be attractive to tourists. However some felt that the "novelty" benefits would be diluted if the signs were more widespread. It should be noted that the representatives that we interviewed were primarily responsible for roads, so others in the local authorities with responsibility for tourism may have had different views.

7 Discussion

The research reported here was conducted to evaluate the effect of the installation of bilingual signs on road safety in Scotland. It was acknowledged at the time of the proposal that using a single methodology (e.g. only reviewing accident data) would not be sufficient to scientifically evaluate the effect of bilingual sign installation on road safety. It was therefore recommended that multiple methods were employed to establish a greater understanding of what impact, if any, bilingual signs have had. The methods proposed included a review of international literature; analysis of accident data; and a survey of drivers. These methods complement each other to provide a holistic representation of the effect of bilingual signs on road safety in Scotland. It is imperative that the results are considered in this way, and not selectively extracted from a single section, so as to provide a valid representation of the research findings.

At the beginning of the report several limitations were highlighted and it is important to acknowledge these when interpreting the results of the research. The limitations stem from confounding variables and the unknown. Confounding variables include factors that concurrently altered at the time of sign installation, like sign size, sign conspicuity, sign safety (structure), and possibly sign location in some circumstances. Unknown variables include additional road safety treatment applied to the roads and any effect of speed limit changes (e.g. 20mph around schools). All of these factors have the potential to influence the research findings and while every attempt has been made to control for them, they should be considered when interpreting the results.

The following discussion is based on the results from all of the sections detailed within the report.

7.1 Bilingual road signs and driver behaviour

The interaction between a sign and a driver is dependent on three things: the sign itself; the sign context, including permanent factors (e.g. sign location and road geometry) and transient factors (e.g. traffic volume); and the driver. The research reported here has sought to explore the effect of a change of sign on the driver, which may have resulted from changes to the sign content (e.g. the addition of Gaelic), or a change to the sign that affected the sign context (e.g. increased size of the signs). To interpret the results of the research presented within the report, it is important to understand driver behaviour in more detail, with consideration of evidence already reported in the literature review.

7.1.1 Understanding driver behaviour

When conditions permit, driving is a self-paced activity. The pace which a driver will choose is not usually a calculated decision and will regularly vary in response to ever changing demands in the environment. The faster the pace, the less time a driver has to process the information around them, and any change that makes the environment more demanding will result in a driver either being unable to cope (and lose control) or cause them to take action (e.g. reduce speed) to allow them to process information at an acceptable level again. Fuller (2005) conceptualises this process in the Task Capability Interface (TCI) model and the theory of Task Difficulty Allostasis (Fuller, 2008).

The TCI model compares the level of demand from the driving task at any particular moment with the capability of the driver. The capability of the driver is constrained by their personal characteristics which creates a 'Capability Range'. This range will have its foundations in a driver's experience and training but may also be mediated, at any time, by factors such as fatigue and stress. Meanwhile, 'Task Demand' is influenced by many on-the-road factors that can make it somewhat unpredictable (e.g. traffic, road geometry, sign comprehension, etc.). However, one of the most important influences over task demand is managed by the driver: speed. Speed has a crucial role to play in the maintenance of the gap between Task Demand and Capability. A change in speed

will have a direct influence on the demand of the driving task. This control over speed allows a driver to maintain a preferred level of Task Demand and therefore within a preferred range of 'Task Difficulty'.

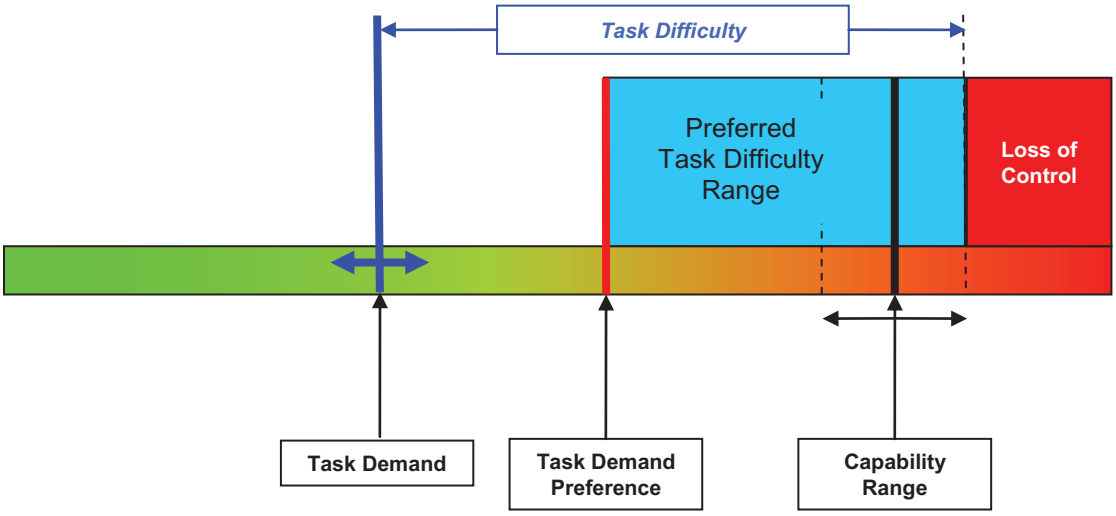


Figure 7.1: Illustration of the Task Capability Interface model (Kinnear, Kelly, Stradling & Thomson, 2009)

Task difficulty is the real-time gap between level of Task Demand and level of Capability. Task difficulty is inversely proportional to this gap as when the gap decreases, task difficulty increases. Therefore, as Task Demand approaches Capability the driver will experience that driving is becoming progressively more difficult and that their safety is more at risk; it has been demonstrated that drivers can use feelings of risk as a measure of Task Demand (Fuller, McHugh & Pender, 2008; Kinnear, Stradling & McVey, 2008). Hence, this gap could otherwise be termed the driver's 'Safety Margin'. It is proposed that we drive within a preferred safety margin that we are prepared to engage with (Fuller, 2005). This process has been conceptualised in the form of Risk Allostasis (Fuller, 2008).

7.1.2 Bilingual signs and task demand

Evidence outlined in the literature review suggested that it was reasonable to consider that complex signs, including bilingual signs, would increase driver workload and distraction. This may simply occur due to the increasing complexity (amount of information) rather than the addition of another language; although there was evidence that the bilingual nature of signs independently influenced driver behaviour. In addition, bilingual signs have been found to take longer to read, and drivers were found to reduce their speed to read more complex signs, including bilingual signs. This finding has been supported in the current survey where all groups of drivers reported slower speeds to pictures of bilingual signs compared to their monolingual equivalents.

This evidence suggests that bilingual signs raise the demand of the driving task, which would consequently reduce a driver's safety margin (i.e. the gap between Task Demand and driver Capability). Evidence from previous simulator research suggested that in high workload conditions drivers were unable to maintain an acceptable headway to the vehicle in front when approaching and reading instructions from a complex (including bilingual) Variable Message Sign. This finding suggests that in certain situations, complex signs have the potential to overload drivers who would have less opportunity to respond to sudden changes in the driving environment.

7.1.3 Bilingual signs, Task Demand and accidents

With research evidence suggesting that there are reasonable grounds to consider that bilingual signs (possibly by virtue of their added complexity) increase Task Demand, and therefore reduce a driver's safety margin, it is important to consider whether this does in fact lead to more accidents. The accident analysis performed for this report found that while individual routes demonstrated some fluctuations in certain types of accidents, overall these results could not necessarily be attributed solely to the installation of bilingual signs and there was no consistent effect whereby accident rates had increased or decreased due to the installation of the signs. In the context of the literature review evidence it might seem surprising that no change in accident rates has been detected, however this can possibly be explained in terms of the TCI model of driver behaviour and consideration of the sign context.

One of the key components of the TCI model is that drivers drive within a preferred range of task difficulty, or safety margin. This range is rightly called a safety 'margin' as it provides the driver with a cushion, a time window perhaps, whereby they can respond to sudden changes in their environment and take avoiding action. While it was conceptualised in the previous section that under high workload conditions, drivers' safety margins are reduced in response to complex signs, this finding is related to the driving context tested, which was based on motorway driving. Nevertheless, other tasks can create a high workload situation, such as talking on a mobile phone. It would seem however, that the remaining safety margin that drivers have, and their behavioural response to maintain their original safety margin (by reducing speed), is enough to mitigate any increased accident risk that might occur in certain high workload situations when driving.

The survey results appear to support this conclusion, for local drivers at least. While local drivers, both with and without Gaelic language ability, reported finding it more difficult to find information on bilingual signs, and report having to stop more often to read bilingual signs, they do not report any significant increases in near-misses or accidents because of bilingual signs. This suggests that while the signs have increased the level of demand on the driver, it has not ultimately led to more accidents or near-accidents, and has possibly been absorbed into a driver's safety margin or through the driver lowering task demand by, for example, slowing down and even stopping to read the sign, as reported by drivers in the survey. While there may be anecdotal evidence of this situation being dangerous, it may be that drivers who have witnessed other drivers slow down, stop or turn in the road to read a sign have considered this to be risky, although not actually witnessed an accident taking place.

The survey data would suggest that tourists may however be at more risk of Task Demand exceeding their Capability when processing bilingual road signs. Tourists reported that in comparison to monolingual signs, they find it more difficult to find information on bilingual signs, they have had to slow down and stop to read bilingual signs, they have taken a wrong turn because of them, been distracted, and crucially, some have perceived to have been involved in a near miss situation because of them. It could be postulated that due to tourists' Task Demand already being increased by driving on unfamiliar roads, the additional demand as a result of the complex signs, in certain circumstances, might push demand so close to the driver's Capability that they experience a near miss. However, it is possible that this situation rarely leads to an accident hence no impact has been detected in the accident analysis. Nevertheless it is worth considering further research to determine the effect of bilingual signs in Scotland on tourists, and possibly types of tourists (e.g. English speaking versus non-English speaking tourists). There are other sub-groups of drivers who may also have difficulty in dealing with an increase in task demand. The accident liability of both young or inexperienced drivers, and older drivers, may be increased because of bilingual signs if they are unable to manage the additional demand. Motorcyclists would also be worthy of further investigation, due to their increased vulnerability to loss of control in the event of losing mental capacity. The scope of this study did not allow for these groups to be

separately explored in enough detail to permit strong conclusions. In addition, tracking accident data to ensure that there is no effect on accident rates would be prudent.

7.2 Bilingual signs in a wider context in Scotland

The survey established that all drivers (Gaelic- and non-Gaelic-reading locals and tourists) found it easier to locate information on monolingual signs than bilingual signs, albeit local respondents with Gaelic language ability found it less of a problem to locate information on bilingual signs. The survey also established that local drivers with no Gaelic language ability and tourists found the monolingual signs more attractive than their bilingual equivalents. Local drivers with Gaelic language ability were indifferent and found neither sign more or less attractive. These results would question whether the signs improve the tourist experience in Scotland, although this cannot be definitively concluded from responses to a single question. Nevertheless, should further installation of bilingual signs be considered on the basis that it will have a positive effect on tourists' experience, it would be worthwhile determining the views of tourists in more detail.

Interviews with local authorities across Scotland found that there was a consideration that bilingual signs may 'give a feeling of being in Scotland' although the novelty may be diluted if signs were commonplace. Unsurprisingly, there were differing considerations depending on the local authority's Gaelic heritage. Local authorities that are more involved in actively promoting Gaelic generally were more inclined to support bilingual road signs as part of this promotion. Conversely, local authorities with less Gaelic heritage felt that roads signs were functional only and the addition of Gaelic may lead to requests for other minority languages to be added to signs.

Of greatest concern to local authorities when considering bilingual road signs is the expense of replacement. In addition, it was also commented that bilingual signs were contrary to the Scottish Government's policy relating to sign clutter.

These views do not necessarily stand for all local authorities in Scotland and these points should not therefore be considered as representative. They are solely indicative of the interviewees we spoke to, although the points raised suggest that further consultation with local authorities in Scotland is necessary should further installation of bilingual signs be considered.

7.3 Conclusion

The evaluation of the effect of bilingual signs on road safety in Scotland has been explored using multiple methods. Results from each method have been considered holistically in the context of existing knowledge of driver behaviour and accident risk.

The lack of research, and the lack of consideration for road safety of multilingual signs in other countries, means that there is a considerable gap in knowledge. As a result, it was necessary to supplement the evaluation with existing literature from other areas that complement and enhance the understanding of the effect of bilingual signs on driver behaviour and crash risk. It can be reasonably deduced from the literature that the installation of bilingual signs will have increased the demand of the driving task for drivers using the signs. While it is possible that in certain high workload conditions this extra demand could result in an increased risk of accident involvement, this situation is probably rare (although possibly more common for tourists). There is evidence from the survey in the current study that drivers may be managing this extra demand through a slight reduction in speed.

It is concluded that on those trunk roads where bilingual signs have been installed, while there is evidence that bilingual signs may have increased the demand of the driving task, that this increase can be absorbed and managed by the driver and therefore does not result in a significant increase in crash risk and accident involvement. Analysis of

accident data in Scotland concurred with this conclusion, as it found no evidence that, overall, accidents increased or decreased as a result of bilingual sign installation.

Further work could explore how this additional demand is managed by specific vulnerable groups of drivers (and riders). In particular, the impact of bilingual signs on tourists, older drivers, young or inexperienced drivers, and motorcyclists.

In addition, the analysis of accidents on bilingual routes will be repeated to include data for additional years. This would increase the statistical confidence of these initial findings.

Acknowledgements

The work described in this report was carried out in the Road Safety Group of the Transport Research Laboratory. The authors are grateful to Shaun Helman who carried out the technical review and auditing of this report.

References

Agg, H.J. (1994). *Direction sign overload*. Project report 77. Crowthorne: Transport Research Laboratory.

Baddeley, A.D. & Hitch, G.J. (1974). Working memory. In G. Bower (Ed.), *The Psychology of Learning and Motivation*, 47–89. New York: Academic Press.

Baguley, P.C. & Cooper, B.R. (2000). *Effects of Bilingual Signs on Road Safety: A Literature Review*. Project Report PR/ISS/30/2000. Crowthorne: Transport Research Laboratory. Unpublished Report available only on direct personal application to TRL's office in Scotland.

Baines, P. & Dixon, C. (2003). *Signs: Lettering in the Environment.* London: Laurence King.

Basacik, D. & Stevens, A. (2008). *Scoping Study of Driver Distraction*. Road Safety Research Report No. 95. Crowthorne: Transport Research Laboratory.

Bowen, R. (1972). *Bilingual Traffic Signs.* Report of the Committee of Inquiry under the Chairmanship of Roderic Bowen. Caerdydd/Cardiff: HMSO.

Burns, P.C., Parkes, A., Burton, S., Smith R. K. & Burch, D. (2002). *How dangerous is driving with a mobile phone? Benchmarking the impairment to alcohol.* TRL report 547. Crowthorne: Transport Research Laboratory.

Euromosaic (1996). *Euromosaic Report*. Retreived from http://www.uoc.edu/euromosaic/web/homean/index1.html

Fuller, R. (2005). Towards a general theory of driver behaviour. *Accident Analysis & Prevention, 37(3),* 461–472.

Fuller, R. (2008). Recent developments in driver control theory: from task difficulty homeostasis to risk allostasis. Paper presented to the *International Conference on Traffic and Transport Psychology*, Washington DC, USA, 31 Aug-4 Sept 2008.

Fuller, R., McHugh, C. & Pender, S. (2008). Task difficulty and risk in the determination of driver behaviour. *Revue Européenne De Psychologie Appliquée/European Review of Applied Psychology, 58(1),* 13-21.

Gaelic Language Plan (2010). *Gaelic Language Plan. The Scottish Government*. Edinburgh: The Scottish Government.

Gordon, R.G., Jr. (ed.) (2005). *Ethnologue: Languages of the World*, Fifteenth edition. Dallas, Tex.: SIL International. Retrieved from http://www.ethnologue.com/.

Green, P. (2002). Where do drivers look while driving (and for how long)? In R.E. Dewar and P.L. Olson (Eds.), *Human Factors in Traffic Safety* (77–110). Lawyers and Judges Publishing: Tucson, AZ.

Grin, F. & Vaillancourt, F. (1999). *The cost-effectiveness evaluation of minority language policies. Case studies on Wales, Ireland and the Basque Country.* Flensburg: European Centre for Minority Issues.

Hall, R.D., Mcdonald, M. & Rutley, K.S. (1991). An experiment to assess the reading time of direction signs. In A.G. Gale, I. Brown, C.M. Haslegrave, I. Moorhead and S.P. Taylor (Eds.), *Vision in Vehicles III* (333–350). Amsterdam: North-Holland.

Hargarten, S.W., Baker, T. & Guptill, K. (1991). Overseas fatalities of United States citizen travelers: An analysis of deaths related to international travel. *Annals of Emergency Medicine, 20 (6),* 622–626.

Hauer, E (1997). Observational before and after studies in road safety. Pergamon Press, Elsevier Science Ltd.: Oxford, UK

Highland Council (1996). *Gaelic Signposting Policy*. 24 April 1996. Cited in G. Puzey (2007). Planning the Linguistic Landscape. Retrieved from https://www.era.lib.ed.ac.uk/bitstream/1842/2118/1/2007PuzeyGDissertationMSc.pdf

Horswill, M.S. & McKenna, F.P. (2004). Drivers' hazard perception ability: situation awareness on the road. In S. Banbury and S. Tremblay (eds.) *A cognitive approach to situation awareness: Theory and application* (155–175). Aldershot: Ashgate Publishing.

Hughes, P.K. & Cole, B.L. (1986). What attracts attention when driving? *Ergonomics, 29,* 311–391.

Jamson, S.L. (2004). Evaluation of techniques to improve the legibility of bilingual variable message signs. *Advances in Transportation Studies, IV,* 71–88.

Jamson, S.L., Tate, F.N. & Jamson, A.H. (2005). Evaluating the effects of bilingual traffic signs on driver performance and safety, *Ergonomics, 48:15,* 1734–1748.

Kinnear, N., Stradling, S. & McVey, C. (2008). Do we really drive by the seat of our pants? In L. Dorn (Ed.) *Driver Behaviour and Training Volume III*, 349-365. Aldershot: Ashgate.

Kinnear, N., Kelly, S.W., Stradling, S. & Thomson, J.A. (2009). *Do we really drive as we feel?* In, Behavioural Research in Road Safety 2007, Seventeenth Seminar. London: Department for Transport.

Klauer, S.G., Dingus, T.A., Neale, V.L., Sudweeks, J.D. & Ramsey, D.J. (2006). *The Impact of Driver Inattention on Near-Crash/Crash Risk: An Analysis Using the 100-Car Naturalistic Driving Study Data.* Washington DC: National Highway Traffic Safety Administration.

Land, M.F. & Lee, D.N. (1994). Where we look when we steer. *Nature, 369,* 742–744.

Landry, R. & Bourhis, R.Y. (1997). Linguistic Landscape and Ethnolinguistic Vitality: An Empirical Study, *Journal of Language and Social Psychology, 6,* 23-49

Lansdown, T.C. (2004). Considerations in Evaluation and Design of Roadway Signage from the Perspective of Driver Attentional Allocation. In C. Castro and T. Horberry (Eds.). *The Human Factors of Transport Signs* (71–82). New York: CRC Press.

Lesage, P.B., (1978). *A Laboratory Investigation of Language Placement Techniques for Bilingual (French/English) Traffic Signs.* Ottawa: Transport Canada Research and Development Centre, Road and Motor Vehicle Traffic Safety Branch.

Lesage, P.B. (1981). *Design and Comprehension of Bilingual Traffic Signs*. Report CR 8101. Ottawa, Canada: Transport Canada Research and Development Centre, Road and Motor Vehicle Traffic Safety Branch.

Lewis-Evans, B. & Charlton, S.G. (2006). Explicit and implicit processes in behavioural adaptation to road width. *Accident Analysis & Prevention, 38(3),* 610–617.

Lumsdon, L. & Page, S.J. (eds) (2004). *Transport and Tourism: Issues and Agenda for the New Millennium*. Oxford: Pergamon.

McEvoy, S.P., Stevenson, M.R. & Woodward, M. (2006). The impact of driver distraction on road safety: results from a representative survey in two Australian states. *Journal of Injury Prevention*, *12(4),* 242–247.

McKenna, F.P. & Farrand, P. (1999). The Role of Automaticity in Driving. In G.B. Grayson (ed.), *Behavioural Research in Road Safety IX*, Crowthorne: Transport Research Laboratory.

Moore, J.C. (2000). *Bilingual Road Signs in Highland Council Area*. Scottish Executive minute for the Minister for Transport and the Environment, 12 September 2000.

Paixao, M.L.T.D'A., Dewar, R.D., Cossar, J.H., Covell, R.G. & Reid, D. (1991). What do Scots die of when abroad? *Scottish Medical Journal*, *36 (4),* 114–116.

Redelmeier, D. A. & Tibshirani, R. J. (1997). Association between cellular-telephone calls and motor vehicle collisions. *The New England Journal of Medicine*, *336(7),* 453–458.

Reed, N. & Robbins, R. (2008). *The effect of text messaging on driver behaviour: A simulator study* (PPR367). Crowthorne: Transport Research Laboratory.

Rutley, K. (1972). *An Investigation into Bilingual (Welsh/English) Traffic Signs*. Report LR 475.Crowthorne: Transport and Road Research Laboratory.

Rutley, K. (1974). *A second investigation into bilingual (Welsh/English) Traffic signs*. TRRL Supplementary Report 34 UC. Crowthorne: Transport and Road Research Laboratory.

Ryder, J.P. (1980). *Bilingual Traffic Signs in Wales: A Review*. Papers in Planning Research 13, Cardiff: Department of Town Planning, Athrofa Gwyddoniaeth a Thechnoleg Prifysgol Cymru - University of Wales Institute of Science and Technology.

Scottish Executive (2002). *Bilingual Signs Feasibility Study*. Document No: 01EQN/1. Newcastle: Scott Wilson.

Scottish Executive (2003). *Macdonald announces extension of use of Gaelic road signs in the West Highlands*. Media and Communications Group, News Release, 20 January 2003.

Scottish Government Statistics (2009). *Reported Road Casualties Scotland 2008.* November 2009. Retrieved from: http://www.scotland.gov.uk/Publications/2009/11/23103624/0.

Sharples, J.M. & Fletcher, J.P. (2001). *Tourist road accidents in rural Scotland*. Scottish Executive Central Research Unit.

Smiley, A. (2000). Behavioural adaptation, safety, and intelligent transportation systems. *Journal of the Transportation Research Board*, *1724,* 47–51.

Strayer, D.L., Drews, F.A. & Johnston, W.A (2003). Cell phone induced failures of visual attention during simulated driving. *Journal of Experimental Psychology: Applied*, 9, 23–32.

Stutts, J.C., Reinfurt, D.W., Staplin, L. & Rodgman, E.A. (2001). *The role of Driver Distraction in Traffic Crashes*. Washington, DC: Foundation for Traffic Safety.

Summala, H. (2007). Towards understanding motivational and emotional factors in driver behaviour: comfort through satisficing. In P. Cacciabue (Ed.) *Modelling Driver Behaviour in Automotive Environments: Critical Issues in Driver Interactions with Intelligent Transport Systems* (pp.189-207). London: Springer-Verlag.

Vaa, T. (2007). Modelling driver behaviour on basis of emotions and feelings: intelligent transport systems and behavioural adaptations. In P. Cacciabue (Ed.) *Modelling Driver Behaviour in Automotive Environments: Critical Issues in Driver Interactions with Intelligent Transport Systems* (pp.208-232). London: Springer-Verlag.

van Driel, C.J.G., Davidse, R.J., & van Maarseveen, M.F.A.M. (2004). The effects of an edgeline on speed and lateral position: A meta-analysis. *Accident Analysis & Prevention, 36(4),* 671–682.

Walker, L. & Page, S.J. (2004). The Contribution of Tourists and Visitors to Road Traffic Accidents: A Preliminary Analysis of Trends and Issues for Central Scotland. *Current Issues in Tourism*, *7:3,* 217–241.

Wallace, B. (2003). Driver distraction by advertising: genuine risk or urban myth? *Municipal Engineering, 156,* 185–190.

Wickens, C.D. (1984). Processing resources in attention. In R. Parasuraman and D.R. Davies (Eds.), *Varieties of attention.* (63–102). New York, NY: Academic Press.

Appendix A Summary table of countries with multilingual signs

Summary of countries with multilingual signs					
Country	**Official or recognised languages**	**Additional languages**	**Bilingual directional signs?**	**Dominant language on bilingual signs (if known)**	**Known research of bilingual signs and road safety**
Austria	German, Slovene, Croatian, Hungarian	Czech, Slovak, Romani	Carinthia: Around 80 Slovene/German signs where at least 10% speak Slovenian, but not widely accepted, and mainly boundary signs	German	None
			Burgenland: No bilingual signs, apart from some street names		
Belgium	Dutch (Flanders), French (Wallonia), German (parts of East Belgium)	-	Brussels: French and Flemish	French	None
			Wallonia: No bilingual signs, but directions in French even for Flemish towns		
			Flanders: No bilingual signs, but directions in Flemish even for French towns		
			Eupen and St Vith (E. Belgium): German/French bilingual signs with French used voluntarily as second language	German	
			Voeren: Flemish region, was officially French/Dutch bilingual, but in 2006 French place names were abolished, as were bilingual road signs	Dutch (dominant until 2006)	
Canada	English and French	-	New Brunswick, parts of Manitoba and Ontario	English	Lesage, 1978, 1981

Czech Republic	Czech	-	German: Bilingual signs not yet introduced Polish: Bilingual signs permitted since 2001, if minority constitutes 10% of the municipality (but only a couple of villages have them)		None
Denmark	Danish	German, Faroese, Greenlandic	The erection of bilingual signs has technically been permitted since 2001 if a minority constitutes 10% of the population of a municipality. However, their introduction has been resisted on the basis of concerns about safety. There is no agreement with Germany about the use of bilingual signs with street names etc, in the Danish-German border region and there is no tradition of using such signs.		None
Finland	Finnish, Swedish	Saami (<1%)	Road signs may be bilingual, depending on the language status of the district in which they are located. A district is considered bilingual if 8% or more (or at least 3000) of the population has Swedish as a mother tongue. The dominant language is presented first on the traffic sign		None
France	French only	-	Breton can be used on road signs in traditionally Breton-speaking areas	French	None

Country	Official or recognised languages	Additional languages	Bilingual directional signs?	Dominant language on bilingual signs (if known)	Known research of bilingual signs and road safety
Germany	German	Danish (in Schleswig-Holstein)	Bilingual signs rarely used		None
		Upper Sorbian (Saxony)			
		Lower Sorbian (Brandenburg)			
		North Frisian (Schleswig-Holstein)			
		Saterland Frisian (Lower Saxony)			
		Romani (across Germany)			
Republic of Ireland	English and Irish Gaelic both official	-	Everywhere except the Gaeltacht regions where Irish is the only official language	Place names are listed in Irish, followed underneath by the English language equivalent place name in capital letters	None
Italy	Italian	Griko, Albanian, German (co-official in Bolzano-Bozen province), French (co-official in Aosta Valley region), Slovene (co-official in some municipalities of Trieste and Gorizia provinces), Sardinian, Occitan, Friulian (Italian law forces bilingualism in Sardinia, Piedmont and Friuli, respectively)	Griko: Only the municipalities of Bova and Bova Marina have bilingual road signs	Italian	None
			Albanian: In certain communes the local authorities support the erection of bilingual road signs		
			German: Bilingual signs on the autoroute and in Bolzano town		
			French: occassional bilingual road signs in the Aosta Valley		
			Slovene: Bilingual signs along the Slovene border in the Udine province		

Netherlands	Dutch, West Frisian (in Friesland)	-	No bilingual road signs, some boundary signs are bilingual in Friesland		None
Norway	Norwegian	-	Some bilingual signs where minority languages are spoken, mostly in Finnmark.		None
Scotland	English, Gaelic	-	Bilingual road signs installed on some trunk roads in north and west Highlands	English	Baguley and Cooper, 2000
Spain	Spanish, Aranese* (co-official in Catalonia), Basque* (co-official in Basque and Navarre), Catalan/Valencian* (co-official in Catalonia, Valencia and Balearic Islands), Galician* (co-official in Galicia)	-	Basque: All road signs in the Autonomous Community of the Basque Country are bilingual	Basque	None
			Catalan: All road signs in the Valencian community are bilingual	Catalan	
Sweden	Swedish (de facto)	Finnish, Meänkieli, Saami, Romani and Yiddish	Some bilingual signs in the north of Sweden		None
Switzerland	German (65%), French (20%), Italian (5%), Romansh (<1%)	-	Bilingual in areas where the minority language is spoken by >30% of the population.	Discretion of local authority; English above Welsh in Wrexham, Flintshire, and South Wales (Monmouth to Swansea). Font, colour same for both languages.	None
Wales	English and Welsh both official	-	Everywhere. First erected in 1970		Rutley, 1972, 1974; Jamson 2004; Jamson *et al.*, 2005

Appendix B Detailed data tables for accident analyses

B.1 Comparison routes

Table B.1: Possible comparison routes

Route number	Road	Description
20	A68	South of Melrose bypass
21	A77	South of Ayr
22	A84	Stirling to Lochearnhead
23	A96	Inverurie – Huntley bypass
24	A96	Huntley bypass to Keith
25	A7	all
26	A90	Ellon to Fraserburgh
27	A96	Keith to Inverness
28	A99	all
29	A86	all
30	A85	Perth to A82
31	A76	all
32	A95	all
33	A83	all
34	A9	N of Tore roundabout

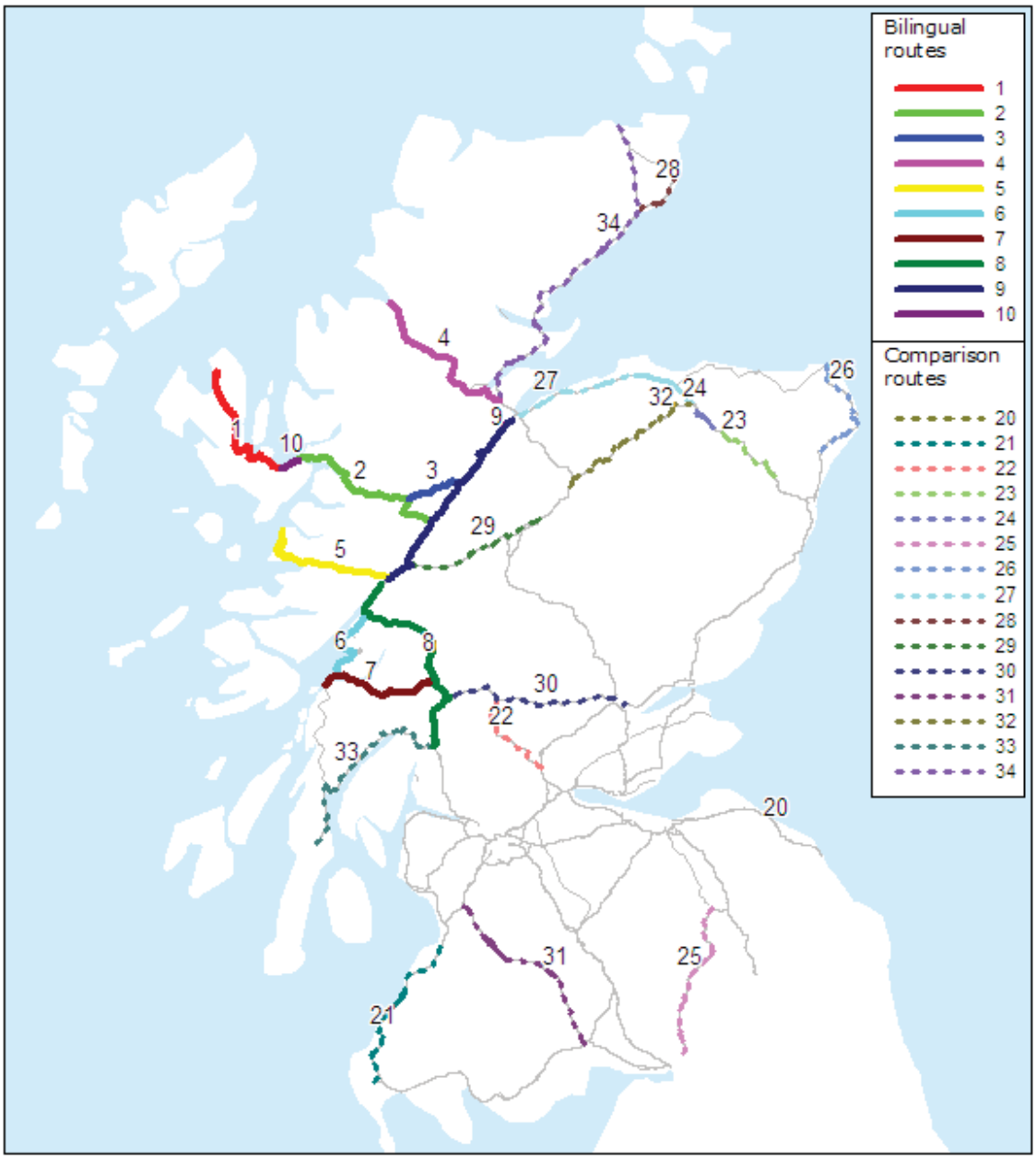


Figure B.1: Map of bilingual sign and possible comparison routes

Consideration of the characteristics of the routes, flows and accidents on the bilingual routes and comparison routes suggested that the routes shown in Table B.2 should be excluded from the analysis. This gave nine bilingual routes and 11 comparison routes remaining in the analysis shown in Figure B.1.

Table B.2: Recommended exclusions

	Route	Road	Description	Reasons for exclusion
Bilingual route	10	A87	Skye Bridge to Broadford	Unknown completion date of works
Possible comparison routes	20	A68	South of Melrose bypass	Section type was recorded as single carriageway climbing lane for entire length. This section type not present on any of bilingual routes. No KSI accidents on route.
	23	A96	Inverurie – Huntley bypass	7% of length 'single carriageway climbing lane'
	24	A96	Huntley bypass to Keith	18% of length 'single carriageway climbing lane'
	27	A96	Keith to Inverness	Includes short dual, climbing lane sections. Included larger proportion of length with speed limit lower than 60mph. AADT of 10,000 compared with average of 2,700 for bilingual routes

Table B.3 shows the percentage of length of the bilingual and the comparison routes made up of each road type.

Table B.3: Length of route by section type

Code	Section type	Bilingual Routes	Comparison routes
D2	Dual 2-lane	<0.1%	<0.1%
O2	Oneway 2-lane carriageway	0.2%	<0.1%
R2/R3	Roundabout	0.1%	0.4%
S2	Single 2-lane carriageway	99.0%	99.3%
S3	Wide single 3-lane carriageway		<0.1%
S4	Wide single 4-lane carriageway		<0.1%
SCLI/O	Single carriageway climbing lane		0.1%
SCPP	Single carriageway with passing places	0.8%	
SL1	Slip 1-lane carriageway		0.1%
WS2	Wide single 2-lane carriageway		<0.1%
	Total length (km)	**631.3**	**874.6**

The vast majority of the bilingual and comparison routes are single 2-lane carriageway, and, as Table B.4 shows, the majority of the routes are also subject to a 60mph speed limit.

Table B.4: Length of route by speed limit

Speed limit	Bilingual routes	Comparison routes
30	5.0%	6.9%
40	5.1%	1.3%
60	89.9%	91.6%
70		0.1%
unknown		0.1%
Total length (km)	**631.3**	**874.6**

In summary, the comparison routes and the bilingual routes are similar in terms of their road characteristics.

Table B.5 shows the distribution of accidents by junction detail. This is recorded in Stats19 as a junction within 20metres.

Table B.5: Accidents by junction detail (2000-2003)

Junction detail	Bilingual routes	Comparison routes
Not at a junction	79%	65%
Roundabout	1%	3%
Mini-roundabout	0%	0%
T or staggered junction	10%	21%
Slip road	1%	1%
Crossroads	0%	3%
Multiple junction	0%	0%
Private drive	3%	3%
Other junction	6%	4%
Total accidents (100%)	**763**	**1,367**

The traffic data showed that there was a greater proportion of PTWs in the traffic on the bilingual routes compared with the comparison routes. The number of accident-involved vehicles by vehicle type is shown in Table B.6.

Table B.6: Accident-involved vehicles by vehicle type (2000-2003)

Vehicle type	Bilingual routes	Comparison routes
Pedal cycle	1.0%	1.6%
PTW	13.4%	7.8%
Car	73.0%	76.5%
Bus or coach	1.5%	1.0%
LGV	4.0%	3.3%
HGV	5.3%	7.8%
Other or unknown	1.8%	2.0%
Total vehicles (100%)	**1,295**	**2,422**

Table B.7 shows the number of accident-involved vehicles on the bilingual routes and the comparison routes by the vehicle manoeuvre before the crash.

Table B.7: Accident-involved vehicles by vehicle manoeuvre (2000-2003)

Vehicle manoeuvre	Bilingual routes	Comparison routes
Reversing	0.2%	0.2%
Parked	1.1%	1.3%
Waiting to go ahead, but held up	3.3%	5.7%
Slowing or stopping	1.8%	2.6%
Moving off	0.2%	0.4%
U-turn	0.5%	0.3%
Turning left	0.7%	1.2%
Waiting to turn left	0.5%	0.2%
Turning right	6.1%	6.6%
Waiting to turn right	1.9%	3.3%
Changing lane to left	0.0%	0.1%
Changing lane to right	0.5%	0.5%
Overtaking moving vehicle on its offside	7.0%	5.3%
Overtaking stationary vehicle on its offside	0.3%	0.6%
Overtaking on nearside	0.2%	0.4%
Going ahead left hand bend	18.2%	13.3%
Going ahead right hand bend	19.6%	12.8%
Going ahead other	37.9%	45.1%
Total vehicles (100%)	**1,295**	**2,422**

The following tables and figures give a general overview of accident, vehicle and casualty data used in the Section 4.4 analysis between the years of 2000 and 2009 on the bilingual signs and comparison routes. Note that throughout this section, accidents on 'bilingual routes' include accidents both before and after the installation of the bilingual signs.

Figure B.2 shows the number of reported injury accidents in each year on the nine bilingual routes and the 11 comparison routes from 2000 to 2009.

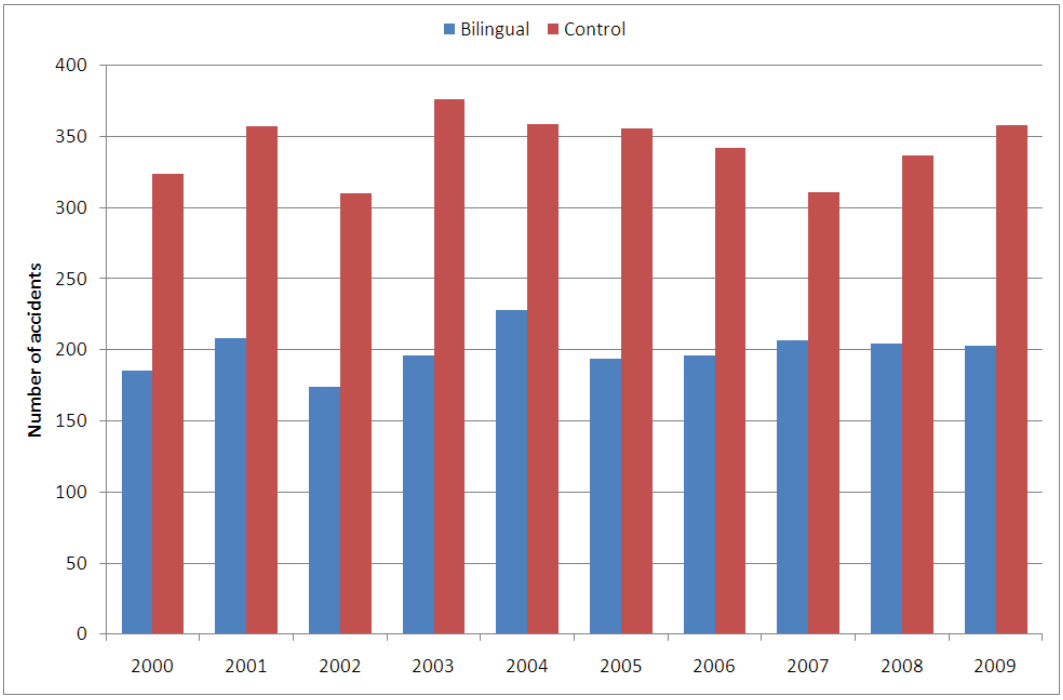


Figure B.2: Number of accidents by year on bilingual and comparison routes

Table B.8 shows the distribution of fatal, serious and slight accidents on bilingual and comparison routes.

Table B.8: Accidents by accident severity (2000-2009)

Accident severity	Bilingual	Comparison
Fatal	5.1%	5.2%
Serious	26.0%	26.1%
Slight	68.9%	68.7%
Total (100%)	1,995	3,430

Over the ten year period the severities of accidents on the bilingual routes and comparison routes were similar. 31.1% of bilingual route accidents were fatal or serious accidents compared to the 31.3% of comparison routes accidents.

Table B.9 and Table B.10 show accident data broken down by junction detail, and weather conditions.

Table B.9: Accidents by junction detail (2000-2009)

Junction detail	Bilingual	Comparison
Not at or within 20m of junction	80.6%	66.5%
Roundabout	0.8%	2.9%
Mini roundabout	0.2%	0.2%
T or staggered	10.3%	18.8%
Slip road	0.4%	0.9%
Crossroads	0.2%	2.7%
Multiple junction	0.2%	0.4%
Private drive or entrance	2.2%	2.9%
Other	5.3%	4.7%
Total	**1,995**	**3,430**

Table B.10: Accidents by weather conditions

Weather	Bilingual	Comparison
Fine	61.6%	69.7%
Raining	32.1%	22.8%
Snowing	2.6%	2.7%
Other/unknown	3.7%	4.8%
Total (100%)	1,995	3,430
Note that conditions include those with high winds		

Figure B.3 shows a breakdown of accidents by month, and Table B.11 and Figure B.4 show a breakdown of accidents by day of the week.

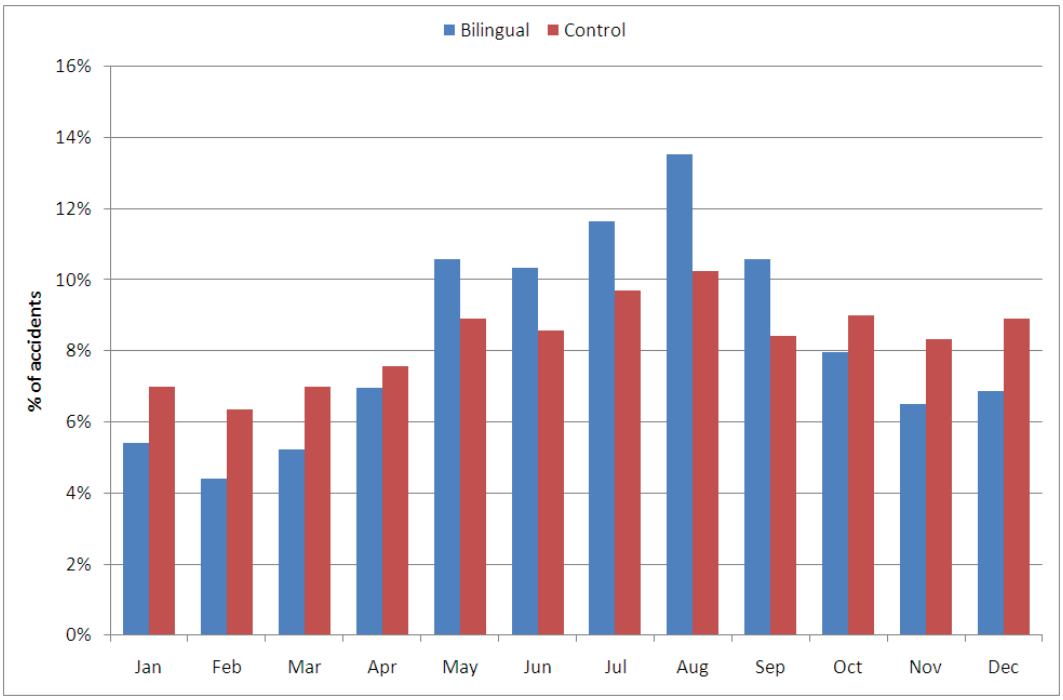


Figure B.3: distribution of accidents by month on bilingual and comparison routes (2000-2009)

57% of accidents occurred between May and September on the bilingual routes compared with 46% on the comparison routes.

Table B.11: Accidents by weekday (2000-2009)

Day of week	Bilingual	Comparison
Monday-Friday	66.5%	69.2%
Saturday-Sunday	33.5%	30.8%
Total (100%)	1,995	3,430

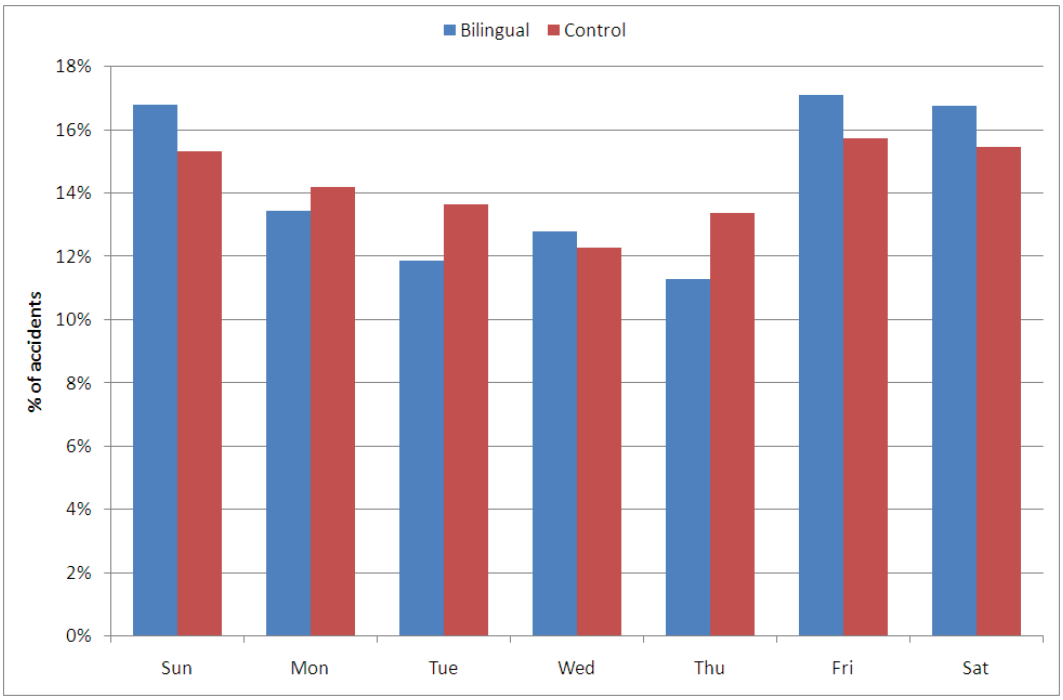


Figure B.4: Distribution of accidents by day of week on bilingual and comparison routes (2000-2009)

B.2 Accident numbers

Table B.12 shows the number of fatal and serious accidents before and after bilingual signs were installed.

Table B.12: Number of fatal and serious accidents by route

Route	Bilingual route		Comparison routes	
	Before	After	Before	After
1-3	45	42	520	516
4	39	26	647	392
5	12	15	510	529
6	17	12	774	274
7	81	18	845	201
8-9	267	25	939	114

Table B.13 shows the accident counts for slight accidents.

Table B.13: Slight accidents by route before and after bilingual signs

Route	Bilingual route		Comparison routes	
	Before	After	Before	After
1-3	104	180	911	1,381
4	50	37	1,233	1,047
5	39	48	893	1,399
6	45	15	1,530	766
7	145	71	1,701	594
8-9	513	83	1,959	329

Table B.14 shows the number of junction accidents before and after the installation of bilingual signs.

Table B.14: Junction accidents (within 20m) before and after bilingual signs

Route	Bilingual route		Comparison routes	
	Before	After	Before	After
1-3	27	37	506	604
4	28	15	670	429
5	11	16	493	615
6	17	4	801	323
7	59	15	873	246
8-9	120	19	987	139

Table B.15 and Table B.16 show the number of accidents involving PTWs and cars respectively.

Table B.15: Number of powered-two-wheeler (PTW) accidents

Route	Bilingual route		Comparison routes	
	Before	After	Before	After
1-3	23	38	*179*	*186*
4	25	11	221	150
5	8	8	177	190
6	11	3	277	97
7	40	10	301	66
8-9	152	18	343	36

Table B.16: Number of Car, Taxi or Minibus accidents

Route	Bilingual route		Comparison routes	
	Before	After	Before	After
1-3	125	188	*1,242*	*1625*
4	67	49	1,626	1224
5	47	52	1,218	1647
6	49	21	1,986	888
7	194	75	2,194	682
8-9	626	93	2,486	381

The number of accidents over the summer months (taken to be April to September) is recorded in Table B.17. The number of months before and after bilingual signs were installed has been altered to account for the fact accidents are only counted for six months of each year.

Table B.17: Number of Accidents in summer months (Apr-Sept)

Route	Months		Bilingual route		Comparison routes	
	Before	After	Before	After	Before	After
1-3	24	33	94	137	695	1035
4	33	24	54	35	996	725
5	24	34	29	34	695	1066
6	41	18	46	18	1265	540
7	44	13	136	41	1342	401
8-9	51	6	512	68	1531	212

The accident count for the winter months (October to March) is displayed in Table B.18.

Table B.18: Number of accidents in winter months (Oct-Mar)

Route	Months		Bilingual route		Comparison routes	
	Before	After	Before	After	Before	After
1-3	27	33	55	85	*736*	*862*
4	33	27	35	28	884	714
5	26	33	22	29	708	862
6	39	19	16	9	1039	500
7	45	15	90	48	1204	394
8-9	51	9	268	40	1367	231

B.3 Modelling parameter estimates

Figure B.5 shows year and month modelling parameter estimates for the all accident data model.

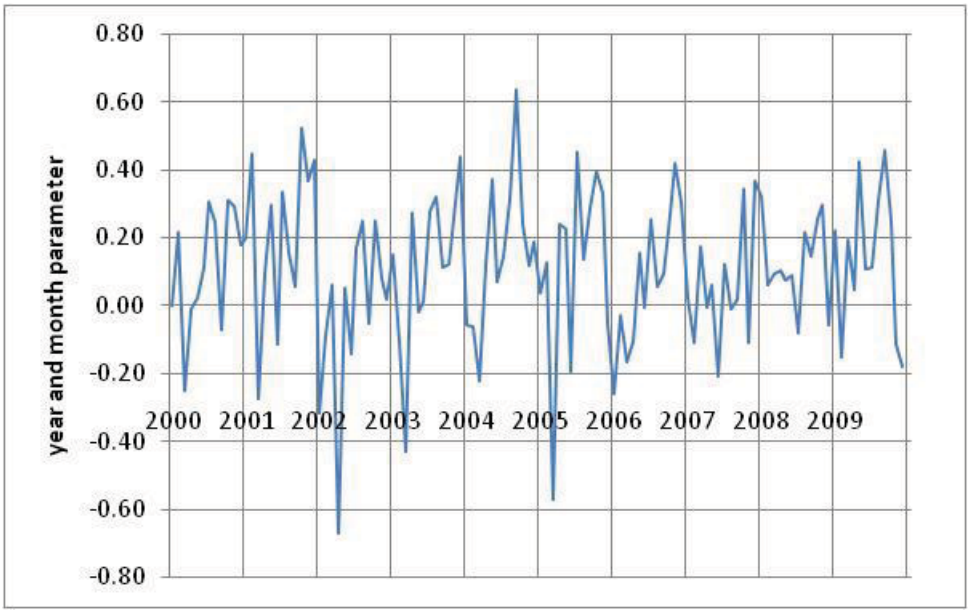


Figure B.5: Year and month parameter estimates for all accident data model, showing combined seasonality and trend effects

Appendix C Survey questionnaires

C.1 – Tourist questionnaire

C.2 – Gaelic/Non-Gaelic resident questionnaire

C.1 Tourist questionnaire

DATE _____/_____/ 2010

INTERVIEWER
INITIALS _____

LOCATION (please circle)
1. Fort William
2. Oban
3. Mallaig
4. Ullapool
5. Inverness
6. Other (please state) _____

Road Signs Survey

Questionnaire T

Filter Questions

F1.	**Are you a visitor to this area?**	Yes (Go to F2)	No (Go to Questionnaire N&G)
F2.	**Are you currently driving on the roads in this area?**	Yes (Begin questionnaire)	No (Close)

Interviewer to read out: **Please look at this picture (indicate C1 on Show card).**

C1.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to Fort William?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C1.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C1.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

Interviewer to read out: **Please look at this picture (indicate C2 on Show card).**

C2.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to the Town Centre?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C2.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C2.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

Interviewer to read out: **Please look at this picture (indicate C3 on Show card).**

C3.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to Invergarry?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C3.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C3.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

Interviewer to read out: **Please look at this picture (indicate C4 on Show card).**

C4.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to Connel?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C4.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C4.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

A1 **Using Scale C to answer, how often do you drive on roads with signs like the one pictured here?**

Every Day	☐1	Once a month	☐4
Several times a week	☐2	Less than once a month	☐5
Once a week	☐3		

A2 **I am going to read out some statements. Please tell me if any of the following apply to you:**

	Yes	No
I have had to slow down to read signs like these	☐1	☐2
I find it difficult to find the information I am looking for on signs like these	☐1	☐2
I have been distracted when driving because of signs like these	☐1	☐2
I have taken a wrong turn because of signs like these	☐1	☐2
I have had to stop the car to read signs like these	☐1	☐2
I have been involved in an accident because of signs like these	☐1	☐2
I had a 'near miss' because of signs like these	☐1	☐2

Q1 **What is your age?** _____years

Q2 **Gender?** Male ☐1 Female ☐2

Q3 **Are you a UK citizen?** Yes ☐1 No ☐2

If No, what is your nationality? _____

Q4 **Please state the postcode / town / country where you usually live.**

Postcode _____ *or Town* _____ *or Country* _____

Q5a **Do you hold a valid UK driving licence?** Yes ☐1 *Go to Q5b* No ☐2 *Go to Q6*

Q5b *If yes, how many points do you have?* _____

Q5c **How long have you had a driving licence?**

_____months or _____years

Q6 **Approximately, how many miles or kilometres do you drive each year?**

_____miles _____kilometres

Q7 **How many road accidents have you been involved in, regardless of blame, in the last 3 years?** _____ accidents

Q8 **Are you currently using Satellite Navigation equipment in the car you are driving in this area?** Yes ☐1 No ☐2

Using Scale D, please rate from 0 to 4 how well you can:

		Not at all				Fluently
Q9	**Read Gaelic**	0	1	2	3	4
Q10	**Write Gaelic**	0	1	2	3	4
Q11	**Speak Gaelic**	0	1	2	3	4

Q12 Using Scale E, please rate how frequently you:

	Very infrequently					Very frequently
Drive fast	1	2	3	4	5	6
Exceed the speed limit in built up areas	1	2	3	4	5	6
Exceed the speed limit on motorways	1	2	3	4	5	6

Q13 Using Scale F, please rate your response to the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I never follow road signs	☐1	☐2	☐3	☐4	☐5
I don't trust road signs to get me where I want to go	☐1	☐2	☐3	☐4	☐5
I think road signs are useful and informative	☐1	☐2	☐3	☐4	☐5
In general, road signs are clear and easy to read	☐1	☐2	☐3	☐4	☐5
I think road signs are ugly and ruin the landscape	☐1	☐2	☐3	☐4	☐5
I always use road signs to direct me to where I want to go	☐1	☐2	☐3	☐4	☐5
I only follow road signs when I'm unfamiliar with the area	☐1	☐2	☐3	☐4	☐5
In general, I think there should be more road signs	☐1	☐2	☐3	☐4	☐5
I think there are too many road signs these days	☐1	☐2	☐3	☐4	☐5
I think road signs add to the character of the landscape	☐1	☐2	☐3	☐4	☐5

Interviewer to read out: **Please look at this picture (indicate C5 on Show card).**

C5.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to Fort William?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C5.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C5.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

Interviewer to read out: **Please look at this picture (indicate C6 on Show card).**

C6.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to the Town Centre?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C6.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C6.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

Interviewer to read out: **Please look at this picture (indicate C7 on Show card).**

C7.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to Invergarry?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C7.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C7.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

Interviewer to read out: **Please look at this picture (indicate C8 on Show card)**

C8.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to Connel?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C8.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C8.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

B1 Using Scale C, how often do you drive on roads with signs like the one pictured here?

Every Day ☐1 Several times a week ☐2 Only on this trip ☐3

B2 I am going to read out some statements. Please tell me if any of the following apply to you:

	Yes	No
I have had to slow down to read signs like these	☐1	☐2
I find it difficult to find the information I am looking for on signs like these	☐1	☐2
I have been distracted when driving because of signs like these	☐1	☐2
I have taken a wrong turn because of signs like these	☐1	☐2
I have had to stop the car to read signs like these	☐1	☐2
I have been involved in an accident because of signs like these	☐1	☐2
I had a 'near miss' because of signs like these	☐1	☐2
The presence of Gaelic makes it difficult for me to read the English on signs like these	☐1	☐2
The presence of English makes it difficult for me to read the Gaelic on signs like these	☐1	☐2

B3 Do you read the English or the Gaelic directions, or both, when driving?

English ☐1 Gaelic ☐2 Both ☐3

Do you have any further comments?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Thank you for your participation and time

C.2 Gaelic/Non-Gaelic resident questionnaire

DATE _____/_____/ 2010

INTERVIEWER
INITIALS _____

LOCATION (please circle)
1. Fort William
2. Oban
3. Mallaig
4. Ullapool
5. Inverness
6. Other (please state)_____

Road Signs Survey

Questionnaire N&G

Filter Questions

F1.	**Do you hold a valid UK driving licence?**	**Yes** (Go to F2)	**No** (Close)
F2.	**Do you regularly drive locally?**	**Yes** (Go to F3)	**No** (Close)
F3.	**Can you read Gaelic?**	**Yes** (Begin questionnaire)	**No** (Begin questionnaire)

Interviewer to read out: **Please look at this picture (indicate C1 on Show card).**

C1.1 Using scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to Fort William?

Not Easily						Very Easily
1	2	3	4	5	6	7

C1.2 At what speed would you drive on this section of road?

_____ mph or _____ kph

C1.3 Using Scale B, do you think this sign makes the scene less or more attractive?

Less						More
-3	-2	-1	0	1	2	3

Interviewer to read out: **Please look at this picture (indicate C2 on Show card).**

C2.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to the Town Centre?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C2.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C2.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

Interviewer to read out: **Please look at this picture (indicate C3 on Show card).**

C3.1 **Using scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to Invergarry?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C3.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C3.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

Interviewer to read out: **Please look at this picture (indicate C4 on Show card).**

C4.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to Connel?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C4.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C4.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

A1 **Using Scale C to answer, how often do you drive on roads with signs like the one pictured here?**

Every Day	☐1	Once a month	☐4
Several times a week	☐2	Less than once a month	☐5
Once a week	☐3		

A2 **I am going to read out some statements. Please tell me if any of the following apply to you:**

	Yes	No
I have had to slow down to read signs like these	☐1	☐2
I find it difficult to find the information I am looking for on signs like these	☐1	☐2
I have been distracted when driving because of signs like these	☐1	☐2
I have taken a wrong turn because of signs like these	☐1	☐2
I have had to stop the car to read signs like these	☐1	☐2
I have been involved in an accident because of signs like these	☐1	☐2
I had a 'near miss' because of signs like these	☐1	☐2

Q1 **What is your age?** _____years

Q2 **Gender?** Male ☐1 Female ☐2

Q3 **Are you a UK citizen?** Yes ☐1 No ☐2

If No, what is your nationality? _____

Q4 **Please state the postcode or town where you usually live.**

Postcode _____ *or Town* _____

Q5a **Do you hold a valid UK driving licence?** Yes ☐1 *Go to Q5b* No ☐2 *Go to Q6*

Q5b *If yes, how many points do you have?* _____

Q5c **How long have you had a driving licence?**

_____months or _____years

Q6 **Approximately, how many miles or kilometres do you drive each year?**

_____miles _____kilometres

Q7 **How many road accidents have you been involved in, regardless of blame, in the last 3 years?** _____ accidents

Q8 **Are you currently using Satellite Navigation equipment in the car you are driving in this area?** Yes ☐1 No ☐2

Using Scale D, please rate from 0 to 4 how well you can:

		Not at all				Fluently
Q9	**Read Gaelic**	0	1	2	3	4
Q10	**Write Gaelic**	0	1	2	3	4
Q11	**Speak Gaelic**	0	1	2	3	4

Q12 Using Scale E, please rate how frequently you:

	Very infrequently					Very frequently
Drive fast	1	2	3	4	5	6
Exceed the speed limit in built up areas	1	2	3	4	5	6
Exceed the speed limit on motorways	1	2	3	4	5	6

Q13 Using Scale F, please rate your response to the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I never follow road signs	☐1	☐2	☐3	☐4	☐5
I don't trust road signs to get me where I want to go	☐1	☐2	☐3	☐4	☐5
I think road signs are useful and informative	☐1	☐2	☐3	☐4	☐5
In general, road signs are clear and easy to read	☐1	☐2	☐3	☐4	☐5
I think road signs are ugly and ruin the landscape	☐1	☐2	☐3	☐4	☐5
I always use road signs to direct me to where I want to go	☐1	☐2	☐3	☐4	☐5
I only follow road signs when I'm unfamiliar with the area	☐1	☐2	☐3	☐4	☐5
In general, I think there should be more road signs	☐1	☐2	☐3	☐4	☐5
I think there are too many road signs these days	☐1	☐2	☐3	☐4	☐5
I think road signs add to the character of the landscape	☐1	☐2	☐3	☐4	☐5

Interviewer to read out: **Please look at this picture (indicate C5 on Show card).**

C5.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to Fort William?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C5.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C5.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

Interviewer to read out: **Please look at this picture (indicate C6 on Show card).**

C6.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to the Town Centre?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C6.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C6.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

Interviewer to read out: **Please look at this picture (indicate C7 on Show card).**

C7.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to Invergarry?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C7.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C7.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

Interviewer to read out: **Please look at this picture (indicate C8 on Show card).**

C8.1 **Using Scale A, please rate from 1 to 7: How easily could you find the information you needed if you were travelling to Connel?**

Not Easily						Very Easily
1	2	3	4	5	6	7

C8.2 **At what speed would you drive on this section of road?**

_____ mph or _____ kph

C8.3 **Using Scale B, do you think this sign makes the scene less or more attractive?**

Less						More
-3	-2	-1	0	1	2	3

B1 **Using Scale C to answer, how often do you drive on roads with signs like the one pictured here?**

Every day	☐1	Once a month	☐4
Several times a week	☐2	Less than once a month	☐5
Once a week	☐3		

B2 **I am going to read out some statements. Please tell me if any of the following apply to you:**

	Yes	No
I have had to slow down to read signs like these	☐1	☐2
I find it difficult to find the information I am looking for on signs like these	☐1	☐2
I have been distracted when driving because of signs like these	☐1	☐2
I have taken a wrong turn because of signs like these	☐1	☐2
I have had to stop the car to read signs like these	☐1	☐2
I have been involved in an accident because of signs like these	☐1	☐2
I had a 'near miss' because of signs like these	☐1	☐2
The presence of Gaelic makes it difficult for me to read the English on signs like these	☐1	☐2
The presence of English makes it difficult for me to read the Gaelic on signs like these	☐1	☐2

B3 **Do you read the English or the Gaelic directions, or both, when driving?**

English ☐1 Gaelic ☐2 Both ☐3

Do you have any further comments?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Thank you for your participation and time

Appendix D Further survey recruitment details

Survey locations

Phase 1

Area	Date	Survey location
Ullapool	8/4/10	Ullapool ferry terminal car park and town
Ullapool	9/4/10	Ullapool ferry terminal car park and town
Inverness	10/4/10	Town centre and Tourist Information Centre on A9
Fort William	8/4/10 & 9/4/10	Fort William Town Centre
Mallaig	9/4/10	Town centre
Oban	10/4/10	Town centre
Tyndrum	11/4/10	Tourist information Centre

Phase 2

Area	Date	Survey location
Ullapool	13/06/10	Ullapool ferry terminal car park
Stornoway	14/06/10	Stornoway town centre and ferry terminal car park.
Stornoway	15/06/10	Stornoway town centre and ferry terminal car park.
Fort William	16/06/10	Fort William town centre and Caol
Fort William	17/06/10	Caol and Mallaig
Oban	18/06/10	Oban ferry terminal car park
Oban	19/06/10	Oban at ferry terminal car park

A record was maintained of potential respondents approached in Phase 2 who were ineligible. The number of respondents approached and the reason for not completing a questionnaire is outlined in the following table:

		Ineligible					
Date	Location	Non-Gaelic reading	Do not drive	Tourist	Not driven on mainlaind	Refused	Total
13-Jun	Ullapool	-	-	-	-	3	3
14-Jun	Stornoway	3	4		4	18	29
15-Jun	Stornoway	-	7	21	3	17	48
16-Jun	Caol / Fort William	64	36	69	-	15	184
17-Jun	Caol / Mallaig	37	19	18	-	8	82
18-Jun	Oban	40	6	30	-	2	78
19-Jun	Oban	33	2	43	-	2	80
	Total	177	74	181	7	65	504

Appendix E Detailed results from the survey

E.1 Analysis methods

The questionnaire used a set of four road sign pairs (monolingual and bilingual equivalents) to determine whether people rate monolingual or bilingual signs as easier to find information on, whether monolingual or bilingual signs make the road scene more or less 'attractive', and whether or not self-rated speed choice on a given road scene differs depending on whether a monolingual or bilingual sign is present. Each of these three dependent variables was analysed separately, for each road sign pair.

The respondents were split into three groups: those who answered the residents' questionnaire and stated that they could read Gaelic, those who answered the residents' questionnaire and stated that they could not read Gaelic, and those who answered the Tourist questionnaire. These groups are referred to throughout the analysis as Gaelic, Non-Gaelic, and Tourist, respectively.

E.1.1 Wilcoxon matched pairs signed rank test

Initially each group was treated independently and a comparison was made between the responses that each participant made about monolingual and bilingual signs. In their general form, the research questions were:

- Q1a: Is there a difference in responses between the monolingual and bilingual signs for Tourists?
- Q1b: Is there a difference in responses between the monolingual and bilingual signs for the Gaelic group?
- Q1c: Is there a difference in responses between the monolingual and bilingual signs for the Non-Gaelic group?

These three questions were asked separately for the three dependent variables, for each sign pair, and for each group.

Formally, the Wilcoxon matched pairs signed rank test is used to test if the difference between a pair (x, y) has a median value of 0. Each pair of values (x, y) corresponds to the result obtained when a single participant measured under two different conditions is tested. It is an alternative to the paired t-test when the population cannot be assumed to be normally distributed.

The assumptions for this technique are:

- Random sampling
- The difference, z, between each pair (x, y) is assumed to be independent
- Each difference, z, comes from a continuous population and is symmetric about a common median
- The values of x and y are ordered so "greater than", "less than" and "equal to" have a meaning

E.1.2 Mann Whitney U test

Another analysis was run to compare the responses of the Gaelic group and the Non-Gaelic group, for each dependent measure ('ease of information', 'self-rated speed choice', and 'attractiveness of road scene'). In their general form the research questions were:

Q2a: Is there a difference between Gaelic and Non-Gaelic responses for the monolingual sign?

Q2b: Is there a difference between Gaelic and Non-Gaelic responses for the bilingual sign?

Q2c: Is there a difference between Gaelic and Non-Gaelic responses for the paired difference between the monolingual and bilingual sign?

Q2c tests whether the *changes* in responses (i.e. the effect of the sign type on responses) are different for the Gaelic and Non-Gaelic groups. That is, is the difference between the scores that participants in one group give for monolingual and bilingual signs much bigger than the difference between the scores for monolingual and bilingual signs that the other group give.

The Mann-Whitney U test is used to test if two independent samples have equally large values. This test is the non-parametric alternative to the unpaired t-test where the population is assumed to be normally distributed.

The assumptions for this technique are:

- Random sampling
- Independent observations
- Under the null hypothesis the distributions of each group are equal
- Under the alternative hypothesis, the probability of an observation from one group exceeding an observation from the other is not equal to 0.5
- Any difference of 1 is the same across the scale

E.1.3 Kruskal-Wallis H test

When it is necessary to make comparisons between the responses for the Gaelic, Non-Gaelic and Tourist groups the Kruskal-Wallis test is used. This test is an extension of the Mann-Whitney U test as it allows comparisons between the scores of more than two groups.

The Kruskal-Wallis test is the non-parametric alternative to one-way ANOVA; the analysis is 'between groups' and hence, the groups must be independent of one another. The assumptions for this technique are the same as those used for the Mann-Whitney U test in E.1.2.

E.1.4 Chi-squared test for Independence

The chi-squared test for independence is used to determine whether two categorical variables are related. The test compares the frequency in each category of one variable to the frequency in the categories of the second variable.

The assumptions required for this test are:

- Random sampling
- Independent observations
- The lowest expected frequency in any cell must be 5 or more

E.1.5 McNemar test

The McNemar test is used to test whether combinations of values between two dependent variables are equally likely. This test is the alternative to the Chi-squared test for independence when the two samples being tested are related; the same people answer the question before and after some intervention. A binomial distribution is assumed.

E.2 The questionnaire sample

In total, 163 tourist questionnaires and 277 resident questionnaires were completed. Of the resident respondents, 101 declared that they could read Gaelic and 176 reported that they could not. The three groups will be defined as Tourist, Gaelic and Non-Gaelic within this section.

The demographics of the samples have been compared in order to check that the results from the three different groups are comparable.

E.2.1 Demographics

Figure E-1 shows the distribution of age for the three questionnaire groups. The mean ages were 42.6 years for Tourists, 49.9 years in the Gaelic group and 42.8 years in the Non-Gaelic group. An ANOVA showed that the mean age was statistically significantly higher ($p<0.01$) for the Gaelic group than the other groups.

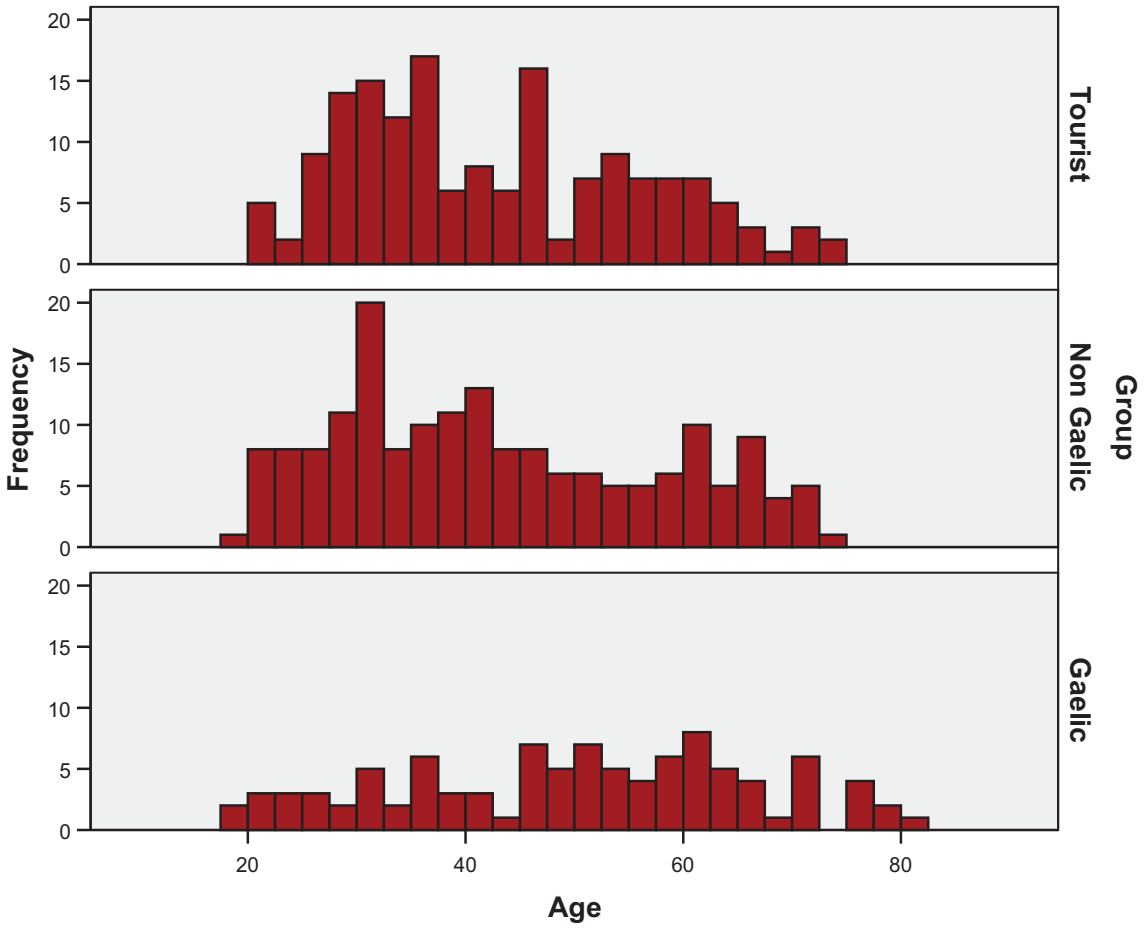


Figure E-1: Age distribution of questionnaire respondents by group

Table E-1 shows that a slight majority of the respondents to the questionnaires in each group were male. Chi-squared tests showed that there was a significant ($p<0.05$) interaction between sex and group when all three groups were included, but no significant interaction once the tourist group was removed from the analysis. This implies that the proportion of males in the tourist group is significantly higher than the Gaelic and Non-Gaelic groups, but that there is no statistical difference in the distribution of sexes in these two resident groups.

Table E-1: Distribution of sex for each group

	Male	Female	Total
Gaelic	57%	43%	101
Non-Gaelic	55%	45%	175
Tourist	68%	32%	163

Each participant was asked to rate their reading, writing and speaking Gaelic capability from 0 (not at all) to 4 (fluently). A small number of the Tourist (3) and Non-Gaelic (9) groups reported that their reading, speaking or writing capabilities were greater than 0. For the Gaelic group Figure E-2 shows the proportion of respondents who classified themselves with up to a certain level of fluency. 98% rated their reading ability at 1 or higher, 76% reported their writing ability was rated as 1 or higher and 95% reported that their speaking ability rated as 1 or higher. 23% reported that they were fluent (rate = 4) readers of Gaelic, 19% said that they were fluent writers and 47% said they were fluent Gaelic speakers.

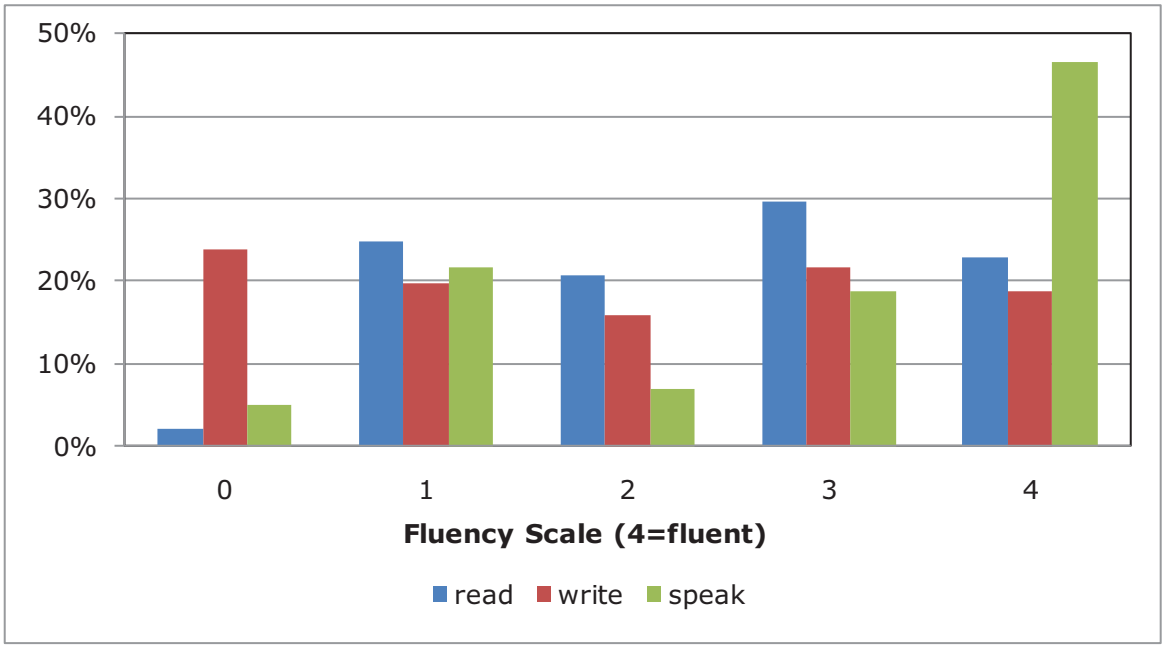


Figure E-2: Proportion of Gaelic group who can read, write or speak Gaelic.

E.2.2 Driving characteristics

All of the Gaelic and Non-Gaelic responders and 80% of the tourist responders held a full driving licence, and of those who did 8% in the Gaelic and Non-Gaelic groups and 15% of the Tourists had points on their licence. The mean length of time that their driving licence had been held was significantly higher ($p<0.01$) for the Gaelic group (28 years) than the other two groups (21 years for Non-Gaelic and 22 years for Tourists), which is directly related to the different age distributions.

The histograms in Figure E-3 show that the distributions of annual mileage is positively skewed and there are some high outliers – in particular one tourist responder stated that she drove 151,000 miles per year. The data have been transformed using the natural logarithm to normalise the distribution as far as possible in order to carry out tests to determine differences between groups. The mean annual mileage for the three groups is statistically significantly ($p<0.01$) higher for the tourist group (13,249 miles per year)

than the resident groups (10,346 and 10,374 for Gaelic and Non-Gaelic groups respectively). Removing the outlier from this analysis makes no difference to the conclusions.

A considerably higher proportion of Tourist responders (42%) were using Satellite Navigation equipment in their car compared to the Gaelic and Non-Gaelic responders (23% and 19% respectively). A chi-squared test showed that there was a significant ($p<0.01$) difference in the proportion of responders using Satellite Navigation equipment between the groups, however no significant difference was observed once the Tourist group had been excluded from the analysis.

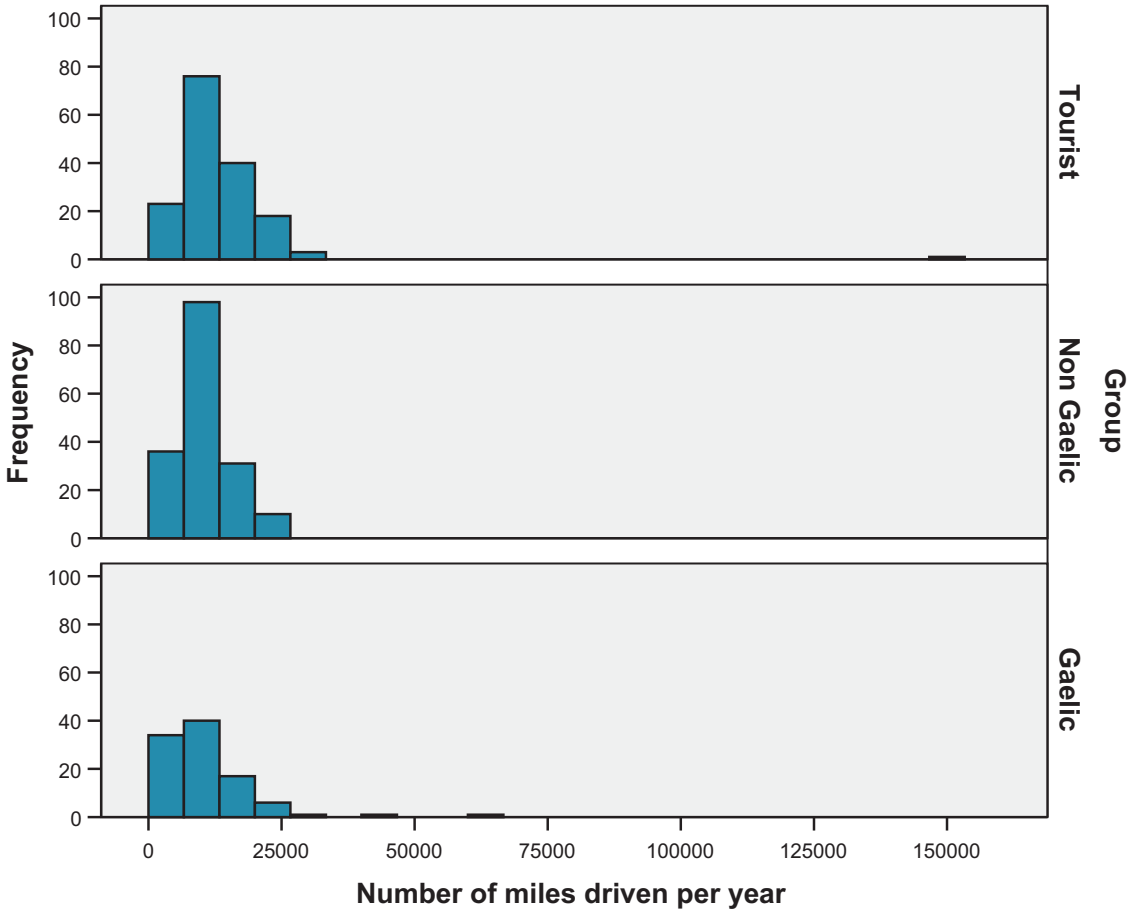


Figure E-3: Annual mileage driven by questionnaire respondents by group

Each participant was asked to rate how frequently they drove fast, followed by how often they exceeded the speed limit in two situations. The responses were based on a West scale and a combination of the rates for each question gives each participant an overall speeding score from 3 (speed very infrequently) to 18 (speed very frequently). The mean score for Gaelic respondents was 6.7 which was lower than the mean scores registered by Non-Gaelic (7.8) and Tourist respondents (8.2). The scores were not normally distributed and so a non-parametric Kruskal Wallis one-way ANOVA was performed and showed that there was a difference in the three samples. Individual Mann-Whitney U tests showed that the difference between the Gaelic and Non-Gaelic distribution was significant ($p<0.01$), and the difference between the Gaelic and Tourist groups was significant ($p<0.01$), but the difference between the Tourist and Non-Gaelic groups was not significant ($p>0.10$).

E.2.3 Accident patterns

Table E-2 shows the number of accidents that participants in each group have had over a three year period before taking the questionnaire.

A non significant result ($p>0.10$) to the Kruskal-Wallis test has shown that the accident patterns do not come from different distributions for the three groups. That is there is no reason to think that responders in any one group are more likely to be involved in an accident than responders in the other two groups.

Table E-2: Distribution of 3-year accident involvement for each group

Number of accidents	Gaelic	Non-Gaelic	Tourist
0	86	146	136
1	11	24	25
2	4	5	2
3	0	0	0
4	0	1	0

E.2.4 Opinions on road signs (Q13)

Question 13 was used to establish if there was a significant difference in drivers' attitudes to road signs across the three groups. There were ten statements and each statement was examined using a Kruskal-Wallis test. There was found to be a significant difference ($p<0.05$) in the responses across the three groups except to the statements 'I never follow road signs' and 'In general road signs are clear and easy to read'.

Excluding Tourists from this analysis, a Mann-Whitney test revealed there were significant differences ($p<0.01$) between the responses to the statements 'I think road signs are ugly and ruin the landscape', 'I always use road signs to direct me', 'I only follow road signs when I'm unfamiliar with the area', 'In general I think there should be more signs' and ($p<0.05$) 'I think road signs add character to the landscape'.

In general, the answers given by tourists were more favourable towards road signs than those given by both the Gaelic and Non-Gaelic groups. This may be due to the fact tourists to Scotland are more likely to need to use the road signs than the residents of the area.

All statements were then considered collectively; providing a summary of driver's attitudes to road signs across the three groups. A Kruskal-Wallis test showed that there was a significant difference ($p<0.01$) in the overall response to question 13 between the groups, however no significant difference ($p>0.05$) was observed once the Tourist group had been excluded from the analysis. As a result, there is little difference in the attitudes of drivers in the Gaelic and Non-Gaelic group however, the responses from drivers in the Tourist group differed considerably from the residents.

This question was designed to act as a control for the picture questions comparing the bilingual to the monolingual signs. In E.3, E.4 and E.5 comparisons are made between the responses given by those in the Gaelic and Non-Gaelic groups. In order for the groups to be comparable, the responses given by the groups need to be as similar as possible. Since the overall attitude to road signs do not differ between these two resident groups no weighting needs to be applied to the answers.

E.2.5 Summary

The Tourist group had different driving characteristics to the resident groups including a higher proportion with points on their licence, a higher probability of using Satellite Navigation equipment and a higher mean annual mileage. There were no differences

detected between Gaelic and Non-Gaelic groups in this category. The Tourist group was also shown to have different attitudes to road signs than the residents.

The number of accidents reported by the three groups was not different; however the Gaelic group were more likely to speed.

Demographically, the Gaelic group were significantly older than the other two groups and there was a significantly higher proportion of males in the Tourist sample than the other two groups.

E.2.6 Weighting

In order for the results for the different groups to be comparable in the next section, the groups need to be as demographically similar as possible. Weights have been applied to the Gaelic group to match age distributions to the other groups, and to the Tourist group to match the distribution of sexes to the other groups (see Table E-3).

Table E-3: Age (Gaelic) and sex (Tourist) weights

	Gaelic	Tourist
18–29	1.5	-
30–39	1.7	-
40–49	1.2	-
50–59	0.6	-
60–69	0.9	-
70+	0.3	-
Male	-	0.8
Female	-	1.4

Unless otherwise stated, where data are presented these are shown as un-weighted numbers, and where tests have been completed, these have been done on the weighted data.

E.3 How easily could you find the information you needed?

E.3.1 Question 1: Is there a difference in rating between the monolingual and bilingual signs?

E.3.1.1 Sign 1

Non-Gaelic

Table E-4 shows the distribution of respondents' scores when asked to rate the ease at which information required to travel to Fort William could be found on the sign. The scale is defined from 1 (not easily) to 7 (very easily). Highlighted in the table are the proportion of participants who rated the bilingual sign easier to read than the monolingual sign (yellow) and those who rated the monolingual sign easier to read than the bilingual sign (green).

The table shows that 10% (highlighted in yellow) of Non-Gaelic participants rated the bilingual sign easier to read than the monolingual and 65% (green in the table) scored the monolingual sign easier to read then the bilingual. 25% recorded no change in the ease at which information could be found from the monolingual to bilingual sign.

Table E-4: Distribution of Non-Gaelic's paired scores for monolingual and bilingual sign 1

		Bilingual							Total
		1	**2**	**3**	**4**	**5**	**6**	**7**	
Monolingual	**1**								*0%*
	2								*0%*
	3					1%			*1%*
	4			1%	2%		2%	1%	*6%*
	5	1%	1%	1%	3%	2%	3%	1%	*11%*
	6	2%	3%	2%	10%	3%	5%	2%	*26%*
	7	6%	3%	3%	8%	12%	7%	17%	*56%*
Total		*9%*	*6%*	*7%*	*23%*	*17%*	*17%*	*21%*	*100%*

*Green cells: monolingual sign easier to read than the bilingual sign
*Yellow cells: bilingual sign easier to read than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

The distribution of scores given by the Non-Gaelic participants is shown in the 'total' row and column in Table E-4. None of the respondents scored the monolingual sign a rating of less than 3; with more than half scoring the maximum rating of 7. The scores across the bilingual sign are more evenly distributed with the majority of people giving the sign a rating of 4.

A Wilcoxon test on the weighted data showed that the Non-Gaelic residents found the monolingual sign significantly easier to find the required information than the bilingual sign ($p<0.01$).

Gaelic

The distribution of scores recorded when Gaelic participants were asked to rate the ease at which information is found on the monolingual and bilingual signs are found in Table E-5. Only 8% of the participants reported that the bilingual sign was easier to find information on than the monolingual. On the other hand, 25% scored the monolingual as easier. The vast majority (67%) scored the monolingual and bilingual signs the same for ease of finding information.

Table E-5: Distribution of Gaelic participants' paired scores for monolingual and bilingual sign 1

		Bilingual							*Total*
		1	**2**	**3**	**4**	**5**	**6**	**7**	
Monolingual	**1**								*0%*
	2								*0%*
	3								*0%*
	4	1%	1%		2%				*4%*
	5					5%	4%		*9%*
	6				1%	1%	5%	4%	*11%*
	7			1%	1%	3%	16%	55%	*76%*
Total		*1%*	*1%*	*1%*	*4%*	*9%*	*25%*	*59%*	*100%*

*Green cells: monolingual sign easier to read than the bilingual sign
*Yellow cells: bilingual sign easier to read than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

The total lines show that the majority scored 7, with a higher majority in the monolingual compared to the bilingual sign.

A Wilcoxon test on the weighted data showed that the Gaelic residents found the monolingual sign significantly easier to find the required information than the bilingual sign ($p<0.01$).

Tourists

Table E-6 shows the distribution of Tourists' scores when asked to rate the ease of finding the required information on the sign. Overall, 5% of participants scored the bilingual sign easier to find the required information and 71% scored the monolingual sign easier to find the required information.

Table E-6: Distribution of tourists' paired scores for monolingual and bilingual sign 1

		Bilingual							*Total*
		1	**2**	**3**	**4**	**5**	**6**	**7**	
Monolingual	**1**								*0%*
	2								*0%*
	3								*0%*
	4	2%	1%	2%	1%	1%	1%		*6%*
	5	2%	3%	1%	7%	4%	3%		*19%*
	6	4%	1%	4%	6%	8%	4%	1%	*28%*
	7	6%	1%	1%	6%	8%	9%	15%	*46%*
Total		*13%*	*5%*	*8%*	*19%*	*21%*	*17%*	*16%*	*100%*

*Green cells: monolingual sign easier to read than the bilingual sign
*Yellow cells: bilingual sign easier to read than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

There were a much higher proportion of participants scoring the monolingual sign highly (5-7) than the bilingual sign, whose scores are more evenly spread across the scale.

A Wilcoxon test on the weighted data showed that the tourists found the monolingual sign significantly easier to find the required information on than the bilingual sign ($p<0.01$).

E.3.1.2 Sign 2

Non-Gaelic

Table E-7 shows 6% of the Non-Gaelic group rated the bilingual sign as easier for finding information on (yellow) than the equivalent monolingual sign. However, 76% rated the monolingual sign as easier (green).

Table E-7: Distribution of Non-Gaelic's paired scores for monolingual and bilingual sign 2

		Bilingual							Total
		1	**2**	**3**	**4**	**5**	**6**	**7**	
Monolingual	**1**								*0%*
	2						1%		*1%*
	3	1%		1%	2%	1%			*4%*
	4	1%	1%	5%	3%	1%			*11%*
	5		4%	3%	5%	4%		1%	*16%*
	6	3%	3%	10%	10%	4%	3%	2%	*35%*
	7	3%	5%	3%	5%	6%	5%	7%	*33%*
Total		*7%*	*12%*	*23%*	*24%*	*25%*	*9%*	*10%*	*100%*

*Green cells: monolingual sign easier to read than the bilingual sign
*Yellow cells: bilingual sign easier to read than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

The totals in Table E-7 show that the majority of scores for the monolingual sign fall towards the high end of the scale (4-7) whereas the scores for the bilingual sign are more evenly dispersed throughout the ratings.

A Wilcoxon test on the weighted data showed that the Non-Gaelic group found the monolingual sign significantly easier to find the required information than the bilingual sign ($p<0.01$).

Gaelic

Table E-8 shows the distribution of scores from the Gaelic group on the ease of finding information for the monolingual and bilingual sign 2. Overall, 10% found it easier to find information relevant to travelling to the town centre on the bilingual sign and 45% scored the monolingual sign higher.

Table E-8: Distribution of Gaelic participants' paired scores for monolingual and bilingual sign 2

		Bilingual							*Total*
		1	**2**	**3**	**4**	**5**	**6**	**7**	
Monolingual	**1**								*0%*
	2	2%							*2%*
	3				1%				*1%*
	4	1%	2%	2%	2%	1%			*8%*
	5		1%	2%	3%	8%	3%		*17%*
	6		1%	3%	4%	3%	10%	5%	*26%*
	7		2%		3%	5%	11%	26%	*47%*
Total		*3%*	*6%*	*7%*	*13%*	*17%*	*24%*	*31%*	*100%*

*Green cells: monolingual sign easier to read than the bilingual sign
*Yellow cells: bilingual sign easier to read than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

Generally, for both signs the Gaelic readers reported high scores (4-7) for the ease of finding information. A larger proportion (46%) rated the bilingual sign as harder to find information on (1-3) than the monolingual sign (10%).

A Wilcoxon test on the weighted data showed that the Non-Gaelic group found the monolingual sign significantly easier to find the required information than the bilingual sign ($p<0.01$).

Tourists

The yellow part of Table E-9 represents the proportion of tourists who rated the bilingual sign 2 as easier to find information on than the monolingual equivalent (6%). In contrast, the part highlighted in green shows that 77% of the tourists' responses rated the monolingual sign as easier to read.

Table E-9: Distribution of tourists' paired scores for monolingual and bilingual sign 2

		Bilingual							*Total*
		1	**2**	**3**	**4**	**5**	**6**	**7**	
Monolingual	**1**								*0%*
	2		1%						*1%*
	3		3%	1%	1%	1%		1%	*5%*
	4	1%	3%	4%	3%	3%		1%	*13%*
	5	4%	1%	6%	7%	4%	1%		*24%*
	6	4%	4%	3%	6%	5%	4%		*26%*
	7	6%	2%	4%	6%	6%	3%	4%	*32%*
Total		*14%*	*13%*	*18%*	*23%*	*19%*	*8%*	*6%*	*100%*

*Green cells: monolingual sign easier to read than the bilingual sign
*Yellow cells: bilingual sign easier to read than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

From the total row and column it can be seen that the majority of tourist responses (32%) rated the monolingual sign as 7 (very easy) to find information whereas the most common score for the bilingual sign was 4.

A Wilcoxon test on the weighted data showed that the tourist group found the monolingual sign significantly easier to find the required information than the bilingual sign ($p<0.01$).

E.3.1.3 Sign 3

Non-Gaelic

Table E-10 shows that only 3% of the Non-Gaelic residents rated bilingual sign 3 as easier to read than monolingual sign 3; 76% rated the monolingual sign higher than the bilingual.

Table E-10: Distribution of Non-Gaelic's paired scores for monolingual and bilingual sign 3

		Bilingual							Total
		1	**2**	**3**	**4**	**5**	**6**	**7**	
Monolingual	**1**								*0%*
	2								*0%*
	3						1%		*1%*
	4			1%	3%	1%			*5%*
	5		1%	3%	5%	5%	1%		*14%*
	6	1%	5%	4%	9%	5%	7%	2%	*32%*
	7	3%	6%	6%	10%	8%	8%	9%	*49%*
Total		*4%*	*11%*	*13%*	*26%*	*19%*	*16%*	*11%*	*100%*

*Green cells: monolingual sign easier to read than the bilingual sign
*Yellow cells: bilingual sign easier to read than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

The row and column totals in Table E-10 show that a very small proportion of the Non-Gaelic readers rated the monolingual sign as difficult to find information on (ratings 1-4) whereas, for the bilingual sign, 55% of the scores were a rating of 1-4: Non-Gaelic readers find it more difficult to find relevant information on the bilingual sign.

A Wilcoxon test on the weighted data showed that Non-Gaelic readers found the monolingual sign significantly easier to find the required information than the bilingual sign ($p<0.01$).

Gaelic

Table E-11 shows the proportion of Gaelic participants who find the bilingual signs easier to find information on is 4%, whilst 43% find it easier to find information on the monolingual sign. Over half of the Gaelic group rated the ease at which information could be found on the monolingual and bilingual signs to be the same.

Table E-11: Distribution of Gaelic participants' paired scores for monolingual and bilingual sign 3

		Bilingual							*Total*
		1	**2**	**3**	**4**	**5**	**6**	**7**	
Monolingual	**1**								*0%*
	2								*0%*
	3								*0%*
	4				1%				*1%*
	5				2%	4%	1%		*7%*
	6	2%			3%	12%	13%	3%	*33%*
	7			2%	2%	6%	13%	37%	*59%*
Total		*2%*	*0%*	*2%*	*8%*	*22%*	*27%*	*40%*	*100%*

*Green cells: monolingual sign easier to read than the bilingual sign
*Yellow cells: bilingual sign easier to read than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

For the Gaelic group the distribution of scores for both the monolingual and bilingual sign is skewed towards the higher end of the scale; these people give higher scores for both monolingual and bilingual signs than the Gaelic group.

A Wilcoxon test on the weighted data showed that Gaelic readers found the monolingual sign significantly easier to find the required information than the bilingual sign ($p<0.01$).

Tourists

The distribution of scores recorded when tourist participants were asked to rate the ease at which information is found on the monolingual and bilingual signs are found in Table E-12. 78% found it easier to find information on the monolingual sign whilst just 4% rated the bilingual sign as easier to find information.

Table E-12: Distribution of tourists' paired scores for monolingual and bilingual sign 3

		Bilingual							*Total*
		1	**2**	**3**	**4**	**5**	**6**	**7**	
Monolingual	**1**								*0%*
	2								*0%*
	3								*0%*
	4	1%	1%	1%	1%	2%			*6%*
	5	2%	2%	5%	6%	4%	1%	1%	*19%*
	6	3%	4%	6%	6%	7%	2%	1%	*30%*
	7	4%	2%	1%	13%	7%	9%	10%	*46%*
Total		*9%*	*9%*	*12%*	*26%*	*20%*	*12%*	*12%*	*100%*

*Green cells: monolingual sign easier to read than the bilingual sign
*Yellow cells: bilingual sign easier to read than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

For tourists, the scores for the bilingual signs were distributed across the 7 ratings. However, no one rated the monolingual signs as having a score of 1-3; the tourists find it easier to find information on the monolingual sign.

A Wilcoxon test on the weighted data showed that tourists found the monolingual sign significantly easier to find the required information than the bilingual sign ($p<0.01$).

E.3.1.4 Sign 4

Non-Gaelic

The distribution of Non-Gaelic respondents who give the monolingual and bilingual signs scores is shown in Table E-13. Of the Non-Gaelic participants, only 3% rated the bilingual sign as easier to find information on than the monolingual and 76% rated the monolingual as easier.

Table E-13: Distribution of Non-Gaelic's paired scores for monolingual and bilingual sign 4

		Bilingual							*Total*
		1	**2**	**3**	**4**	**5**	**6**	**7**	
Monolingual	**1**								*0%*
	2								*0%*
	3					1%			*1%*
	4		1%	1%	3%				*4%*
	5		3%	4%	4%	3%	1%		*15%*
	6	1%	2%	5%	9%	7%	3%	1%	*27%*
	7	3%	5%	5%	12%	10%	6%	13%	*53%*
Total		*4%*	*11%*	*14%*	*27%*	*20%*	*10%*	*14%*	*100%*

*Green cells: monolingual sign easier to read than the bilingual sign
*Yellow cells: bilingual sign easier to read than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

The totals show that the ratings given for the bilingual sign were fairly evenly distributed across the scores; conversely, over half the scores for the monolingual sign were recorded to be a 7 (very easy).

A Wilcoxon test on the weighted data showed that the Non-Gaelic group found the monolingual sign significantly easier to find the required information than the bilingual sign ($p<0.01$).

Gaelic

As shown in Table E-14, 60% of the Gaelic participants recorded no change in the rating given from the monolingual to bilingual sign. 37% decreased their scores; they found it more difficult to find information on the bilingual sign and only 3% rated the bilingual sign as easier to find information on.

Table E-14: Distribution of Gaelic's paired scores for monolingual and bilingual sign 4

		Bilingual							Total
		1	**2**	**3**	**4**	**5**	**6**	**7**	
Monolingual	**1**								*0%*
	2								*0%*
	3		1%		1%				*2%*
	4						1%		*1%*
	5	1%			1%	5%		1%	*8%*
	6		2%		4%	3%	15%		*24%*
	7	1%		1%	5%	6%	12%	41%	*65%*
Total		*2%*	*3%*	*1%*	*11%*	*14%*	*28%*	*42%*	*100%*

*Green cells: monolingual sign easier to read than the bilingual sign
*Yellow cells: bilingual sign easier to read than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

The majority of the responses to both signs fell into the scores 6-7 (very easy); the Gaelic readers find it easy to find information on both bilingual and monolingual signs.

A Wilcoxon test on the weighted data showed that the Gaelic group found the monolingual sign significantly easier to find the required information than the bilingual sign ($p<0.01$).

Tourists

Table E-15 shows the distribution of tourists paired scores in response to sign 4. 74% of tourists rated the monolingual sign as easier to read whilst only 4% displayed the opposite view: the bilingual was easier to read.

Table E-15: Distribution of Tourists' paired scores for monolingual and bilingual sign 4

		Bilingual							Total
		1	**2**	**3**	**4**	**5**	**6**	**7**	
Monolingual	**1**								*0%*
	2				1%				*1%*
	3								*0%*
	4	1%	1%	3%	1%	2%			*7%*
	5	2%	1%	4%	2%	5%	1%	1%	*15%*
	6	4%	4%	4%	6%	9%	4%	1%	*31%*
	7	4%	2%	2%	6%	11%	8%	11%	*45%*
Total		*10%*	*8%*	*13%*	*16%*	*27%*	*13%*	*12%*	*100%*

*Green cells: monolingual sign easier to read than the bilingual sign
*Yellow cells: bilingual sign easier to read than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

The bulk of the responses for the monolingual sign are recorded as easy (5-7) whilst the responses for the bilingual sign are fairly evenly distributed across the 7 ratings.

A Wilcoxon test on the weighted data showed that tourists found the monolingual sign significantly easier to find the required information than the bilingual sign ($p<0.01$).

E.3.2 Question 2: Is there a difference between Gaelic and Non-Gaelic responses?

E.3.2.1 Sign 1

Monolingual sign

Figure E-4 shows the distribution of scores given to ease of finding the required information on the monolingual sign by the Gaelic and Non-Gaelic groups. The scale is defined from 1 (not easily) to 7 (very easily). There is a higher proportion of the Gaelic group that rate the sign as 7: very easily than any other score or the Non-Gaelic group.

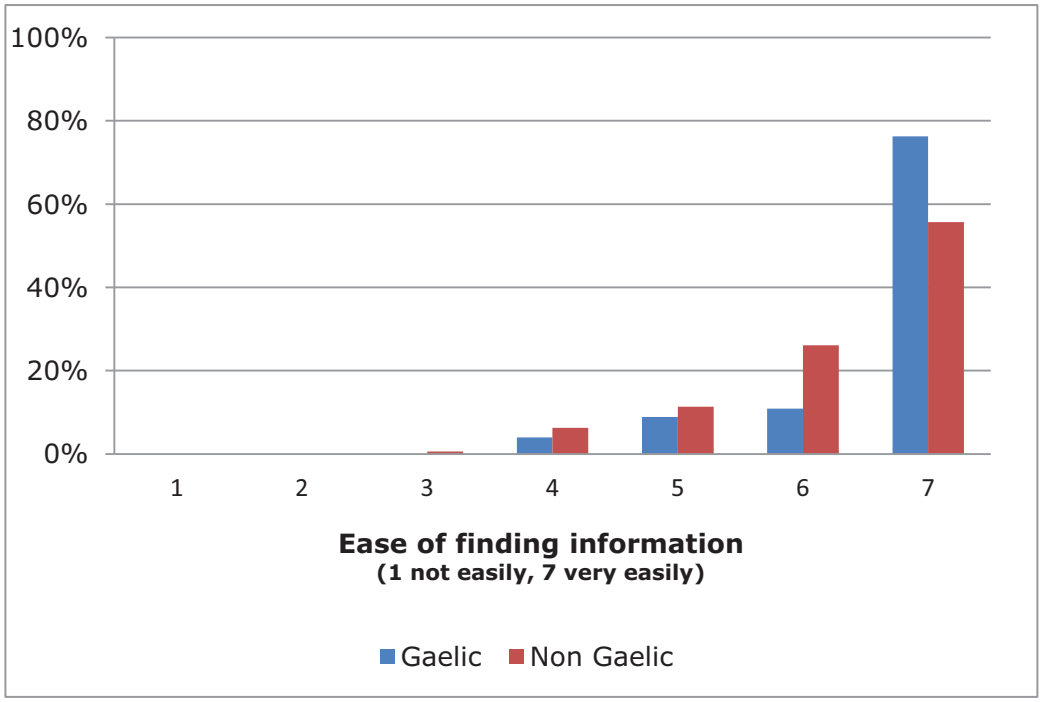


Figure E-4: Ease of finding information on monolingual sign 1 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Bilingual sign

Figure E-5 compares the scores given by the Gaelic and Non-Gaelic group to the ease of finding the correct information on bilingual sign 1. The scores from the Non-Gaelic group are fairly uniformly distributed across the scale with a higher proportion of scores given for the lower scores than the Gaelic group. The majority of the Gaelic group score the ease of finding information on bilingual sign 1 as 6 or 7 (very easily).

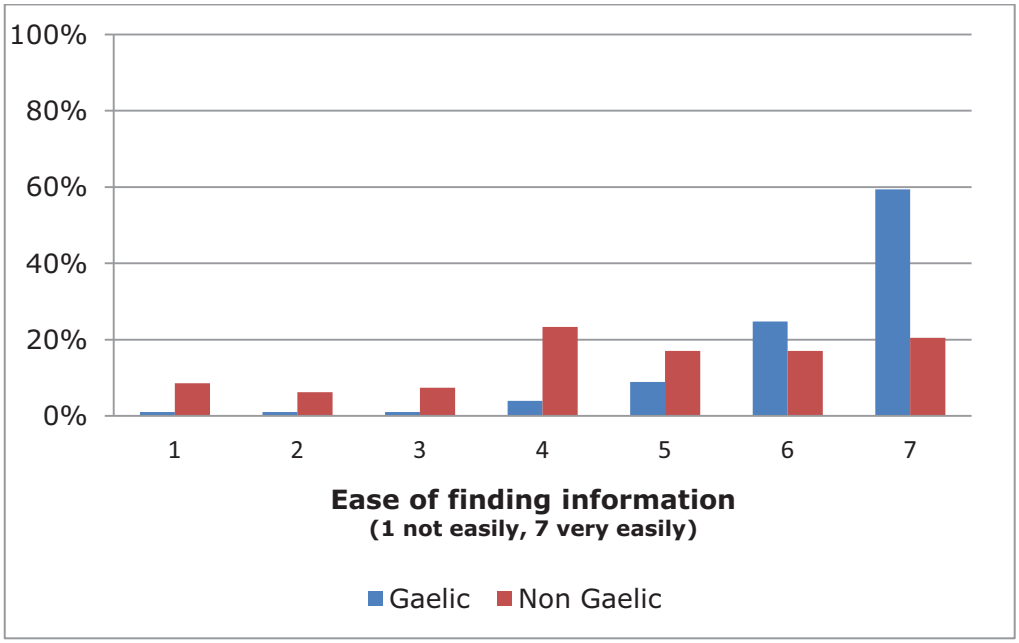


Figure E-5: Ease of finding information on bilingual sign 1 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups. Figure E-5 shows that Gaelic find it much easier to find the information on the bilingual signs than the Non-Gaelic participants.

Difference between monolingual and bilingual sign

Changes in responses between the monolingual and bilingual sign 1 are calculated by subtracting the score given for the bilingual sign from the score for the monolingual sign for each participant. Figure E-6 shows the distribution of these changes for the Gaelic and Non-Gaelic groups. The scale runs from -6 (participants who rated the bilingual sign 6 points higher than the monolingual sign in ease of finding information) to 6 (participants who rated the monolingual sign 6 points higher than the bilingual sign in ease of finding information).

Of those who change their scores, the majority of the Gaelic and Non-Gaelic groups think that the monolingual sign is easier to find the information. A high proportion (67%) of the Gaelic group gives the same score for ease of finding information to monolingual and bilingual sign 1. Differences in the Non-Gaelic group are much more common and have a bigger range.

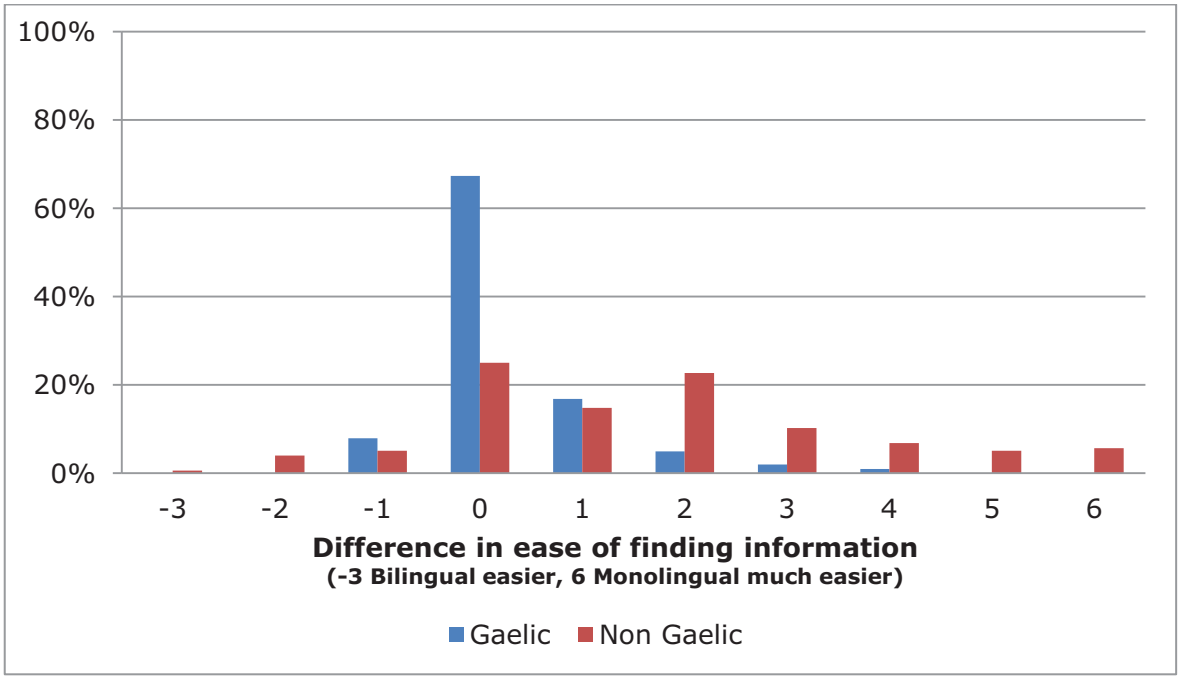


Figure E-6: Difference in ease of finding information on bilingual and monolingual sign 1 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of difference scores given by the Gaelic and Non-Gaelic groups.

E.3.2.2 Sign 2

Monolingual sign

Figure E-7 shows the distribution of scores given to ease of finding the information required to travel to Fort William on the monolingual sign by the Gaelic and Non-Gaelic groups. A higher proportion of the Gaelic group score the ease at which information can be found on the monolingual sign as a 7 (very easily) than the Non-Gaelic group.

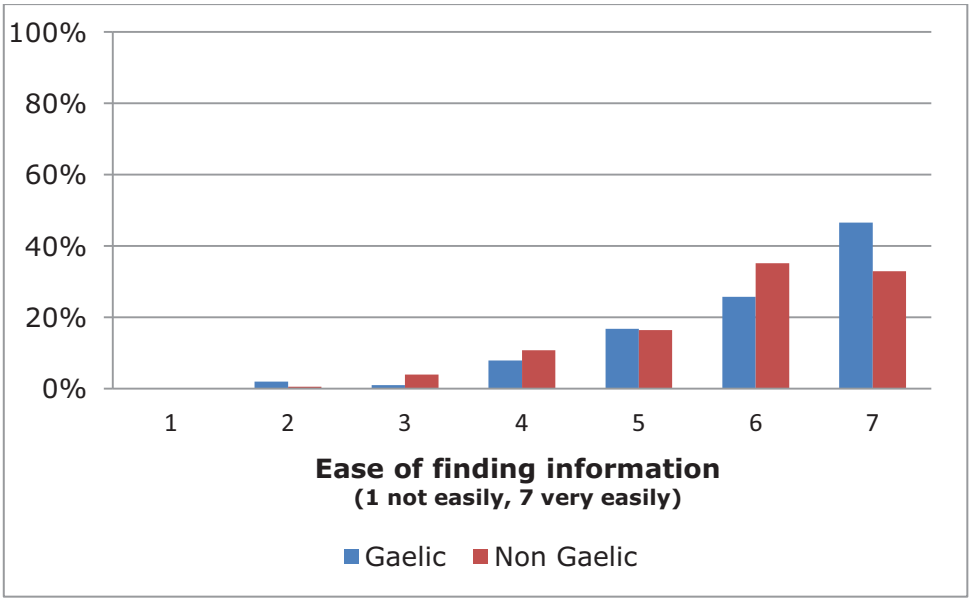


Figure E-7: Ease of finding information on monolingual sign 2 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.05$) in the distribution of scores given by the Gaelic and Non-Gaelic groups for the monolingual sign.

Bilingual sign

The scores given by the Gaelic and Non-Gaelic group to the ease of finding the correct information on bilingual sign 2 are compared in Figure E-8. The majority of the scores for the Non-Gaelic group tend to be located around the 3-5 rating whereas, the Gaelic group seem to have rated higher in ease of finding information (mostly 5-7).

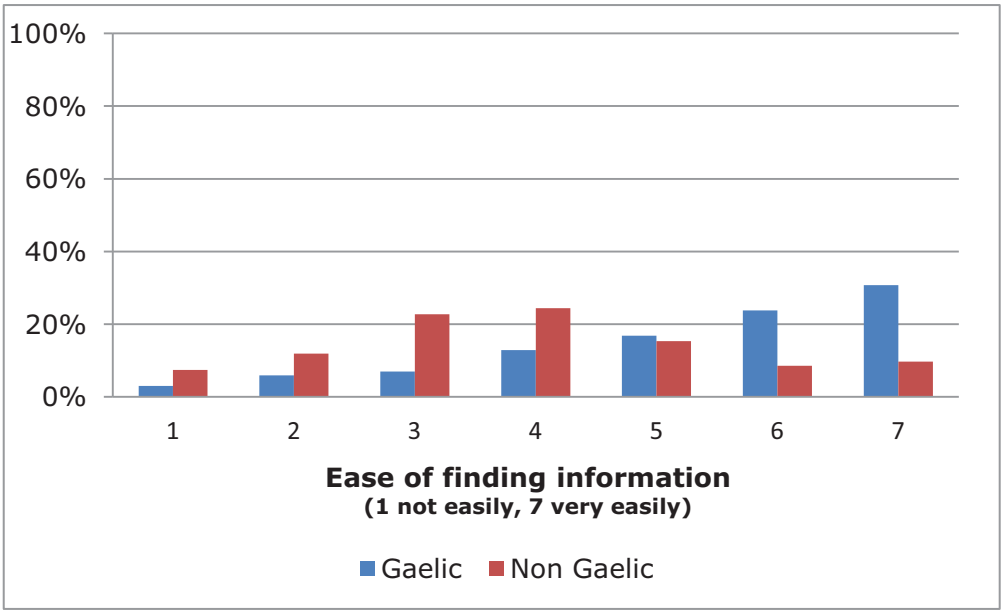


Figure E-8: Ease of finding information on bilingual sign 2 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups. As a result, the Gaelic group find it easier to find information on the bilingual sign than the Non-Gaelic group.

Difference between monolingual and bilingual sign

Figure E-9 shows the distribution of the change in score (monolingual minus bilingual score) for the Gaelic and Non-Gaelic groups. The scale runs from -6 (participants who rated the bilingual sign 6 points higher than the monolingual sign in ease of finding information) to 6 (participants who rated the monolingual sign 6 points higher than the bilingual sign in ease of finding information).

A higher proportion of the Gaelic respondents kept their score for the monolingual and bilingual sign the same (difference = 0) than the Non-Gaelic group. The high proportion of participants who have recorded a change of 1-6 suggests that in general, for both the Gaelic and Non-Gaelic group, the majority of people find it easier to read monolingual than bilingual signs.

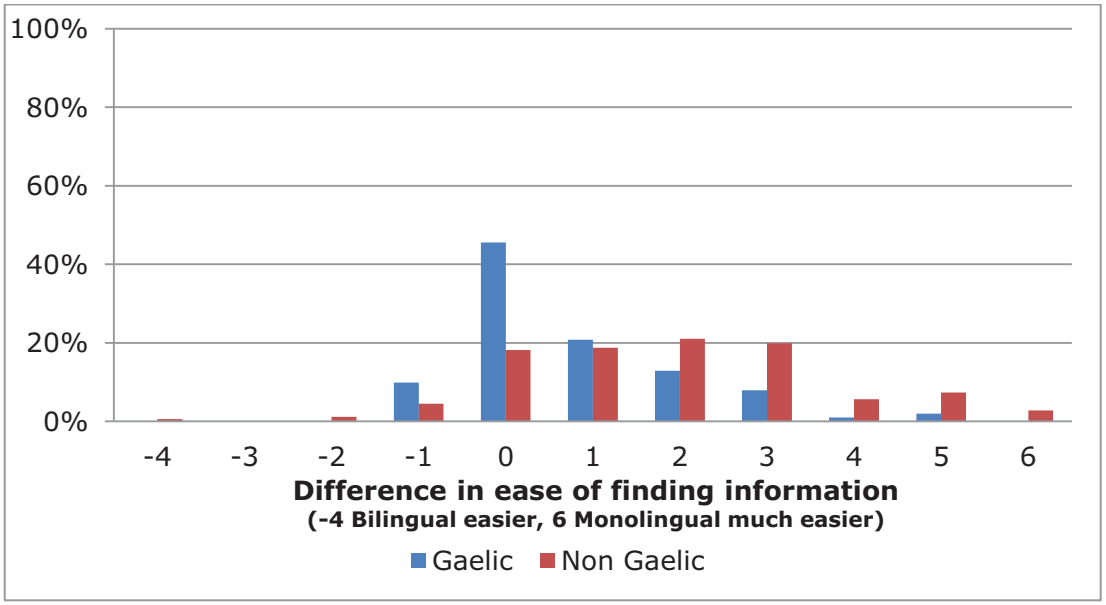


Figure E-9: Difference in ease of finding information on bilingual and monolingual sign 2 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of difference scores given by the Gaelic and Non-Gaelic groups. Figure E-9 shows that the Gaelic and Non-Gaelic groups are changing their scores in a different way; the Gaelic group are more consistent with their ratings than the Non-Gaelic group.

E.3.2.3 Sign 3

Monolingual sign

The distribution of the scores for Gaelic and Non-Gaelic participants for ease of finding information is displayed in Figure E-10. A higher proportion of Gaelic respondents rate the score as a 6 or 7 (very easily) than the Non-Gaelic group.

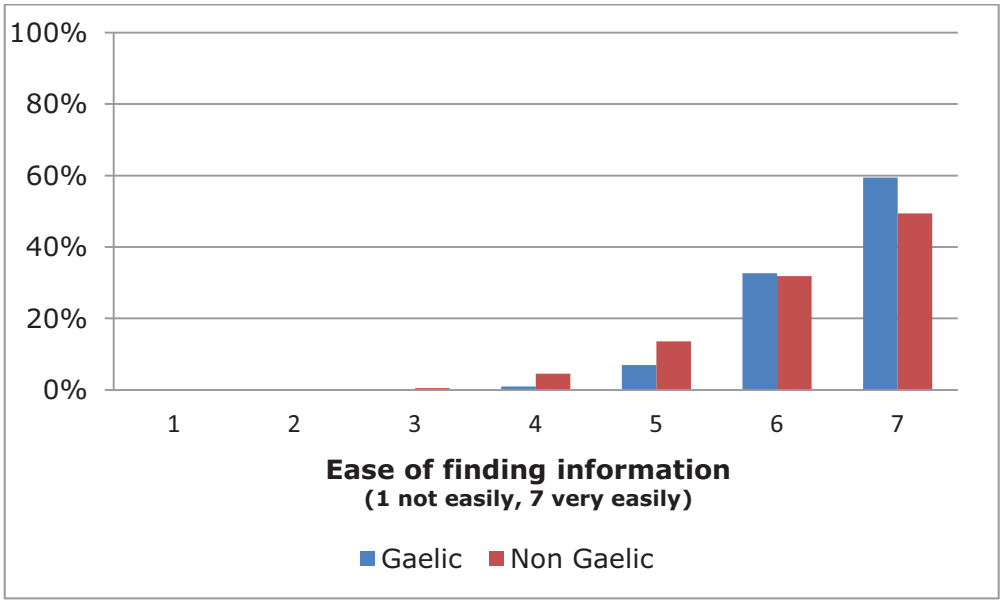


Figure E-10: Ease of finding information on monolingual sign 3 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.05$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Bilingual sign

Figure E-11 shows the proportion of people in each group who rate the bilingual sign as 1 (not easy) to 7 (very easy) for the ease at which information can be found. More Gaelic people rate the bilingual sign as a (5-7) than the Non-Gaelic people; the Gaelic group find it easier to find information on the bilingual sign than those who cannot read Gaelic.

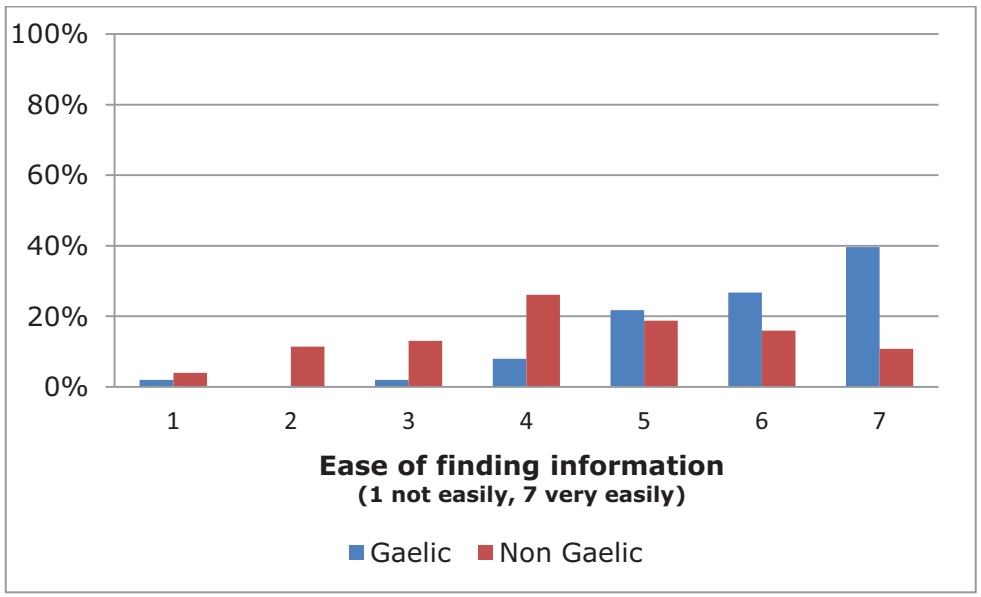


Figure E-11: Ease of finding information on bilingual sign 3 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups. On average, the rating given by the participants in the Gaelic group was higher for the bilingual sign than the rating given by the Non-Gaelic group.

Difference between monolingual and bilingual sign

The change in the score for ease of finding information recorded for sign 3 when it changes from a monolingual to bilingual sign is shown for Gaelic and Non-Gaelic residents in Figure E-12. The scale ranges from -6 (the bilingual sign is 6 points easier to find information on) to 6 (the monolingual sign is easier).

Similarly to signs 1 and 2, there is a higher proportion (54%) of Gaelic people who do not change their score than the Non-Gaelic participants (22%). The Non-Gaelic people who do change their mind tend to have a bigger difference in the ratings from monolingual to bilingual signs.

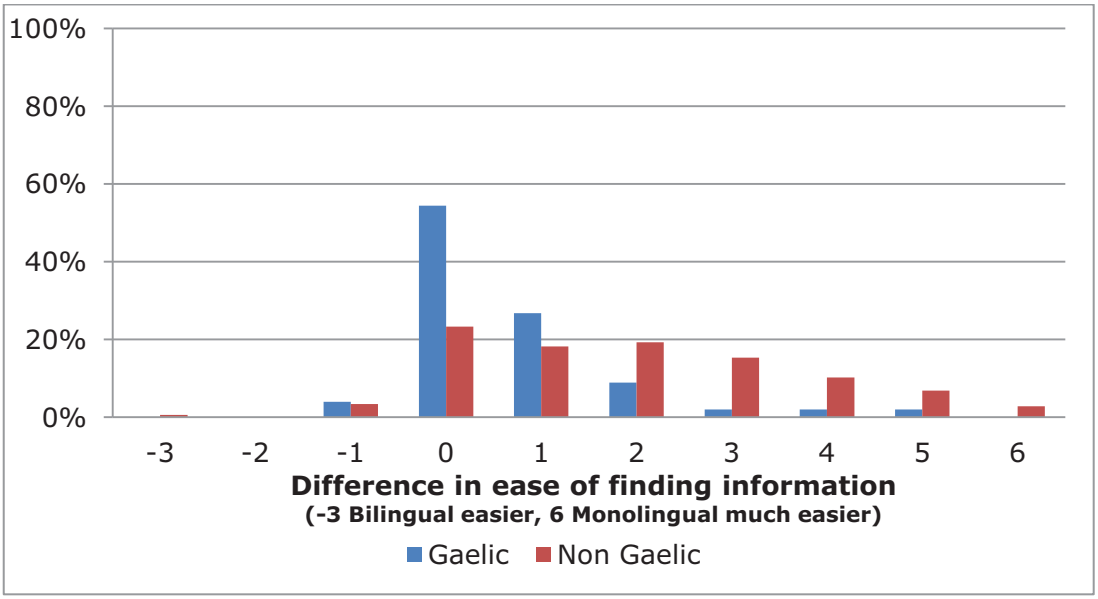


Figure E-12: Difference in ease of finding information on bilingual and monolingual sign 3 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of difference scores given by the Gaelic and Non-Gaelic groups.

E.3.2.4 Sign 4

Monolingual sign

Figure E-13 shows that a higher percentage of the Gaelic group give a rating of 7 (very easy to find information) than the Non-Gaelic group.

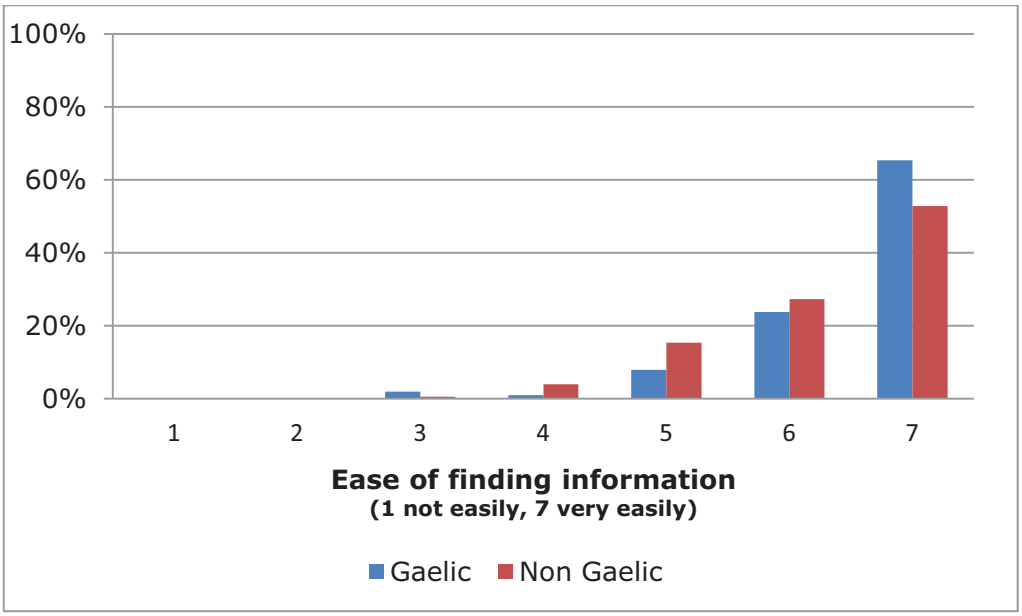


Figure E-13: Ease of finding information on monolingual sign 4 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.05$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Bilingual sign

The distribution of scores for ease of finding information on the bilingual sign 4 is more evenly distributed for the Non-Gaelic readers than the Gaelic; who tend to rate the bilingual sign as very easy to find information (see Figure E-14).

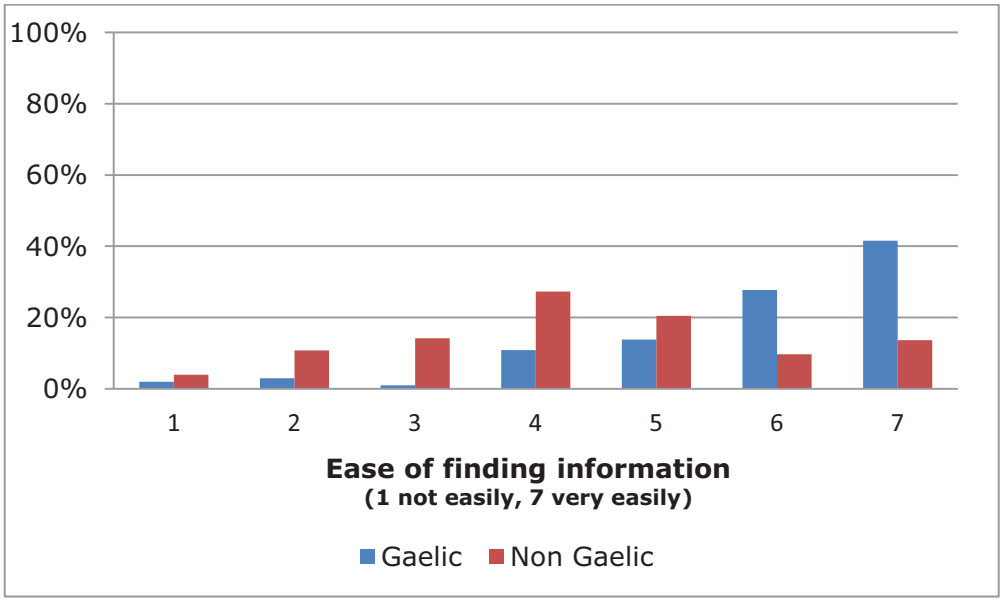


Figure E-14: Ease of finding information on bilingual sign 4 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups. The Gaelic group find it easier to locate information on the bilingual sign than the Non-Gaelic group.

Difference between monolingual and bilingual sign

Figure E-15 shows the difference in the ratings given to the monolingual and bilingual signs for the Gaelic and Non-Gaelic groups. A negative rating implies that the participant recorded the bilingual sign as being easier to find information on whilst a positive rating implies the monolingual is easier.

The majority of the Non-Gaelic group found it easier to find information on the monolingual sign. Within the Gaelic group, over 60% of participants show no difference in the scores given for the monolingual and bilingual version of sign 4.

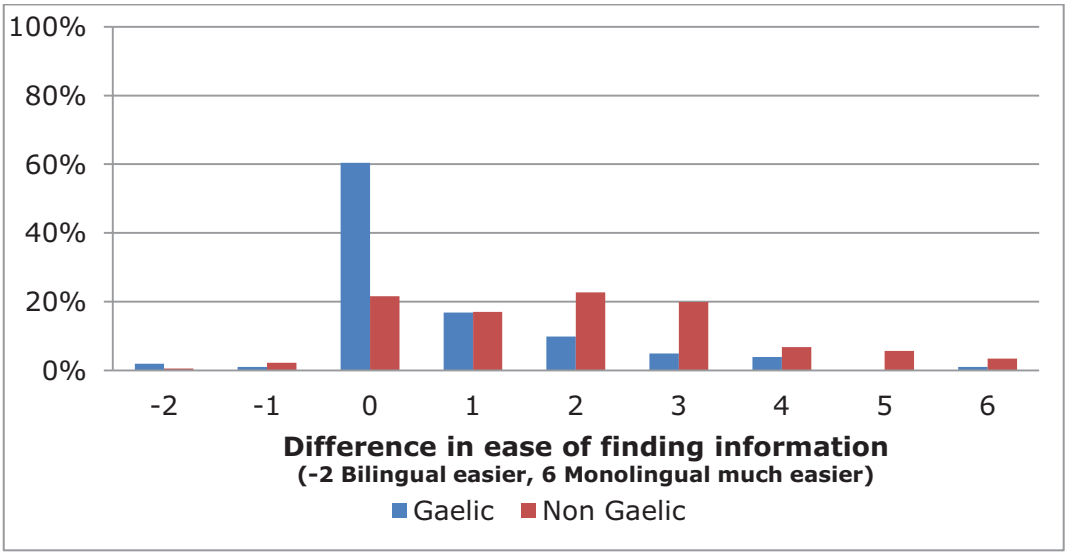


Figure E-15: Difference in ease of finding information on bilingual and monolingual sign 4 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of difference scores given by the Gaelic and Non-Gaelic groups. Those in the Non-Gaelic group tend to record lower scores for the bilingual sign than the monolingual whereas the changes in the scores for the members of the monolingual sign are much smaller.

E.4 At what speed would you drive on this section of road?

E.4.1 Question 1: Is there a difference in the self-reported speed between the monolingual and bilingual signs?

As the speed distributions are skewed and skewed differently for different groups, the non parametric tests discussed in Section E.1 have been used to analyse these speed data. Box plots present the quartile values of the data: the median (middle value) is represented by the line across the middle of the box; the box represents the interquartile range (the middle 50%) from the first to the third quartile and the minimum and maximum points are represented by the extreme lines. Outliers are represented by circles and stars beyond the minimum and maximum lines.

E.4.1.1 Sign 1

Non-Gaelic

Figure E-16 shows a boxplot of the self-reported speed for the Non-Gaelic group on the monolingual and the corresponding bilingual sign route. The median value recorded on the monolingual route was higher than that on the route with the bilingual sign. There was a smaller range of responses for the speeds recorded for the bilingual route. There was one large outlier in the responses for the bilingual sign where the respondent reported a speed of 70mph.

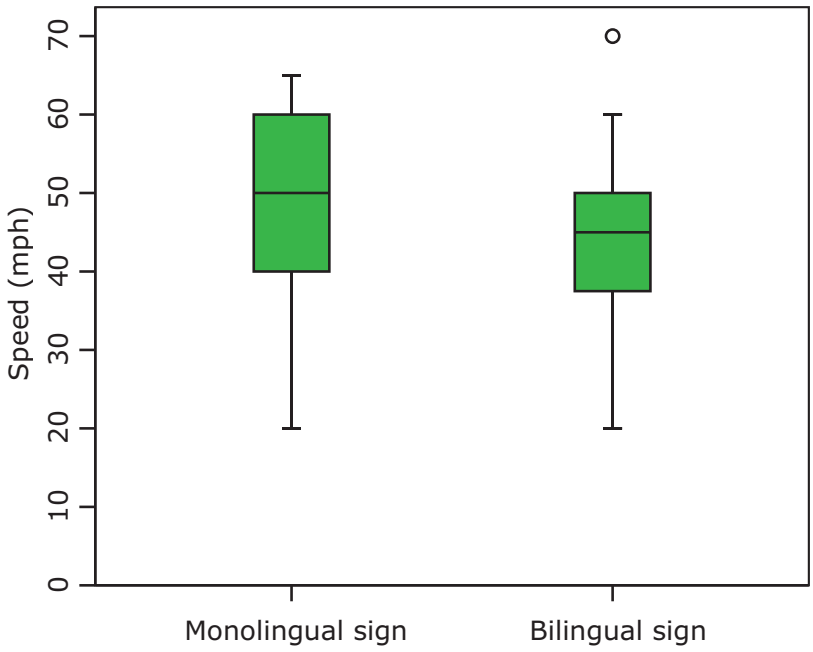


Figure E-16: Boxplot of Non-Gaelic participants self-reported speeds for monolingual and bilingual sign 1

A Wilcoxon test on the weighted data showed that the speed recorded by the Non-Gaelic group for the monolingual sign was significantly different from the speed reported for the bilingual sign ($p<0.01$).

Gaelic

Figure E-17 shows the distribution of speeds reported for monolingual and bilingual sign 1 by the Gaelic group. The median, upper and lower quartiles are higher for the monolingual sign suggesting that the bilingual nature of the sign would slow the Gaelic people down. The Gaelic group quoted a wider range of speeds for the bilingual sign than they did for the monolingual equivalent. For both the monolingual and bilingual sign, one response was considered to be an outlier (this was not recorded by the same person in both cases).

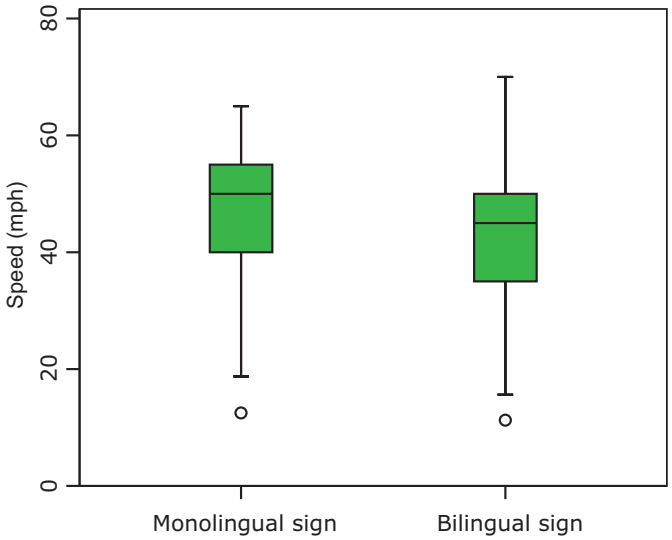


Figure E-17: Boxplot of Gaelic participants self-reported speeds for monolingual and bilingual sign 1

A Wilcoxon test on the weighted data showed that the speed recorded by the Gaelic group for the monolingual sign was not significantly different from the speed reported for the bilingual sign ($p>0.1$).

Tourists

Tourists' self-reported speeds are recorded for sign 1 in Figure E-18. The responses given for the bilingual sign were more diverse than that of the monolingual sign. The median was lower for the bilingual sign showing that on average people would travel slower on a bilingual route. There were two outliers of particularly low values with monolingual sign.

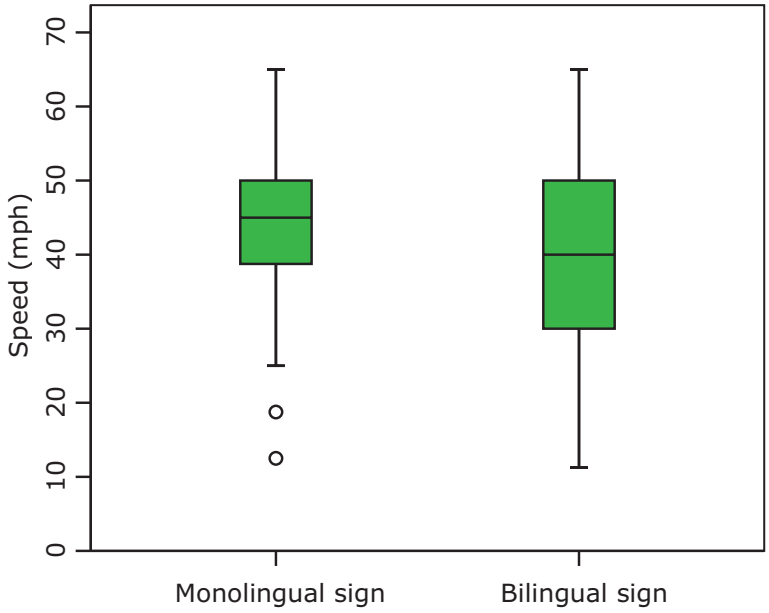


Figure E-18: Boxplot of tourist participants self-reported speeds for monolingual and bilingual sign 1

A Wilcoxon test on the weighted data showed that the speed recorded by tourists for the monolingual sign was significantly different from the speed reported for the bilingual sign ($p<0.01$).

E.4.1.2 Sign 2

Non-Gaelic

The median speed reported falls at the same speed for monolingual and bilingual sign 2 (see Figure E-19); on average Non-Gaelic readers would not alter their speed upon seeing a bilingual sign. The interquartile range is smaller for the bilingual sign, suggesting that there was less variance in the middle 50% of the data for this sign: the speeds were more consistent. There were two outliers for the bilingual sign with speeds reported at 50mph and 60mph.

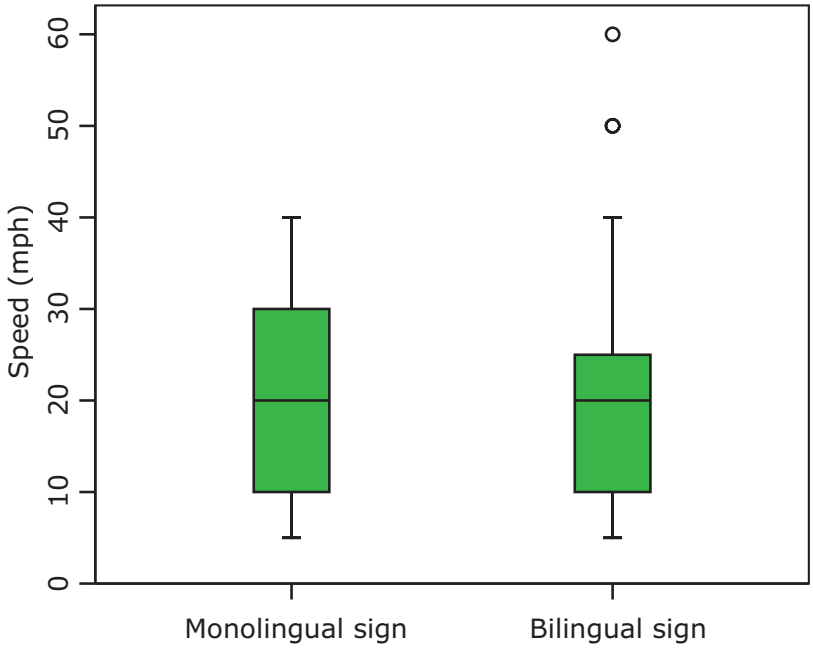


Figure E-19: Boxplot of Non-Gaelic participants self-reported speeds for monolingual and bilingual sign 2

A Wilcoxon test on the weighted data showed that the distribution of speeds recorded by the Non-Gaelic group for the monolingual sign was not significantly different from the distribution of speeds reported for the bilingual sign ($p>0.1$).

Gaelic

The speeds reported in Figure E-20 by the Gaelic participants for the bilingual sign, varied more than the monolingual version. Since the median falls at 30mph for both signs, the bilingual sign would on average have no effect on the speed of the Gaelic drivers. 30mph is also the upper quartile for both signs which implies that at least 25% of the answers were 30mph.

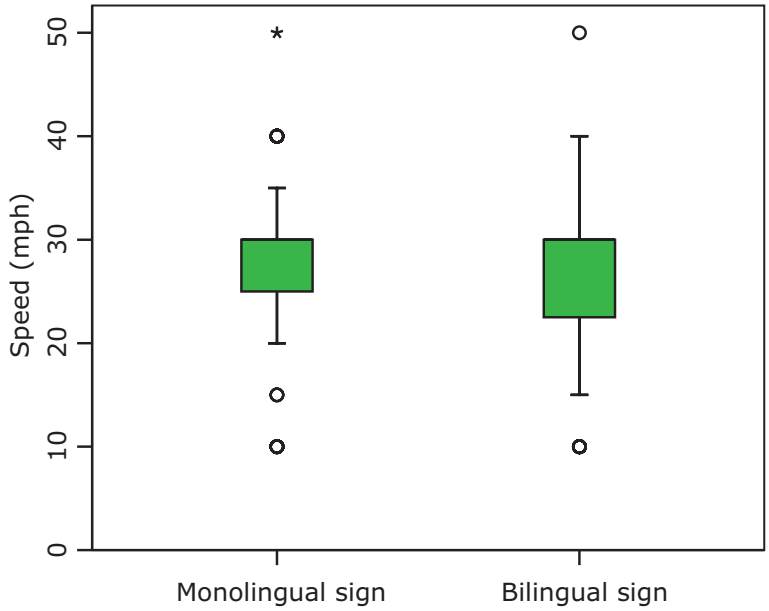


Figure E-20: Boxplot of Gaelic participants self-reported speeds for monolingual and bilingual sign 2

A Wilcoxon test on the weighted data showed that the distribution of speeds recorded by the Gaelic group for the monolingual sign was significantly different from the distribution of speeds reported for the bilingual sign ($p<0.05$).

Tourists

A boxplot displaying the median, interquartile range and range of the data collected for tourists on reported speeds is shown in Figure E-21. The medians did not differ.

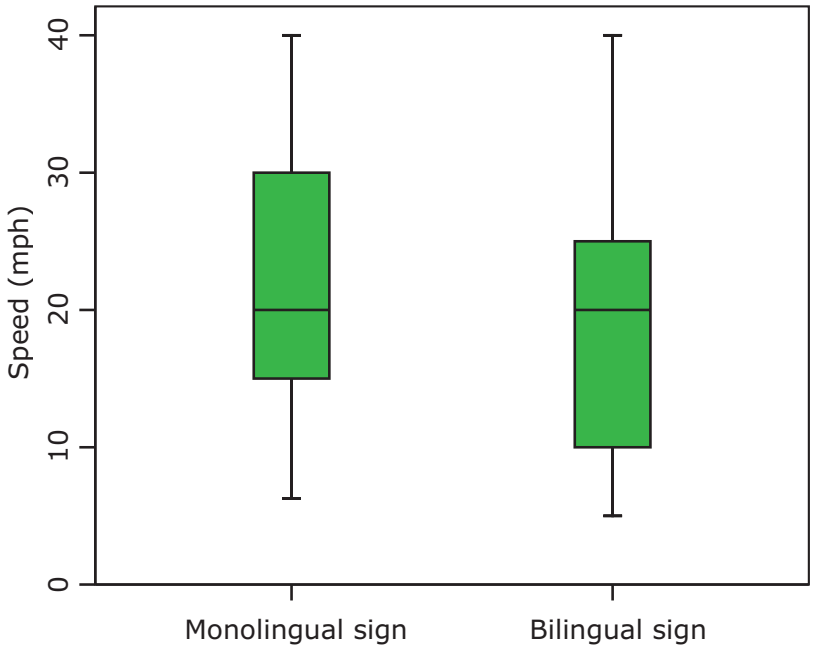


Figure E-21: Boxplot of tourist participants self-reported speeds for monolingual and bilingual sign 2

A Wilcoxon test on the weighted data showed that the speed recorded by tourists for the monolingual sign was significantly different from the speed reported for the bilingual sign ($p<0.01$).

E.4.1.3 Sign 3

Non-Gaelic

The median and interquartile range falls in the same place for both the speeds recorded for the monolingual and bilingual route (Figure E-22). This implies that the Non-Gaelic drivers would do the same speed regardless of the sign type displayed. The range shows that the responses for the bilingual sign included at least one person who would break the speed limit at the scene displayed in the picture.

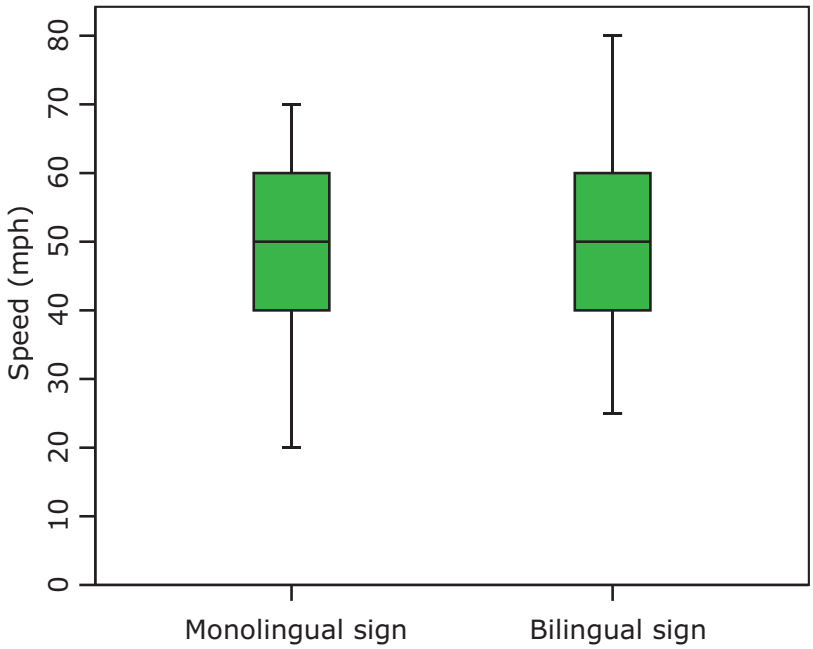


Figure E-22: Boxplot of Non-Gaelic participants self-reported speeds for monolingual and bilingual sign 3

A Wilcoxon test on the weighted data showed that the speed recorded by the Non-Gaelic group for the monolingual sign was not significantly different from the speed reported for the bilingual sign ($p>0.05$).

Gaelic

Figure E-23 shows the data for Gaelic respondents. The median, interquartile range and upper range limit fall at the same speeds on the corresponding boxplots of speeds reported by the Gaelic group for the monolingual and bilingual sign. This suggests there is little difference in the effect the bilingual sign would have on the speed of the Gaelic group compared to that of the monolingual sign. The lower range of the monolingual sign is lower than on the bilingual route; a wider range of answers was given for the speed on the monolingual route.

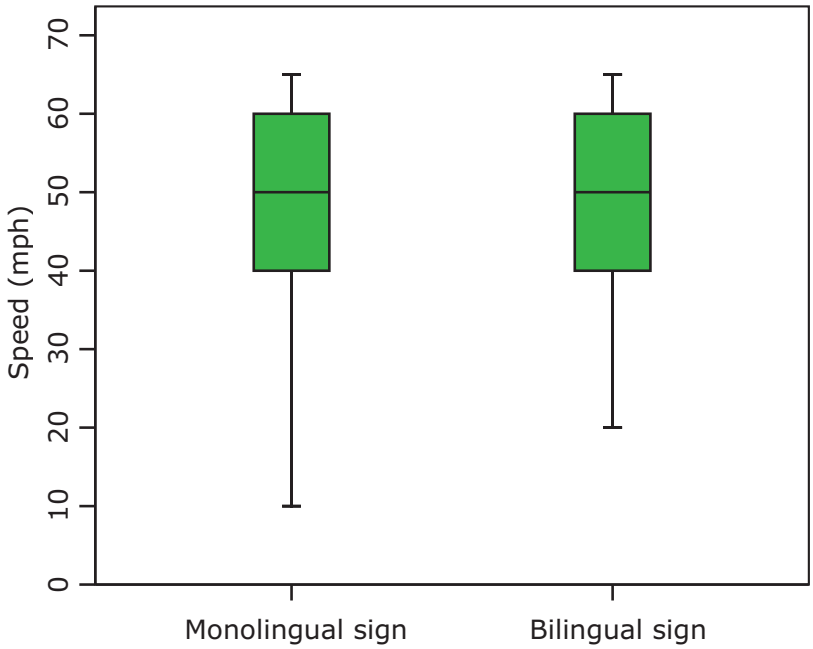


Figure E-23: Boxplot of Gaelic participants self-reported speeds for monolingual and bilingual sign 3

A Wilcoxon test on the weighted data showed that the speed recorded by the Gaelic group for the monolingual sign was not significantly different from the speed reported for the bilingual sign ($p>0.1$).

Tourists

Figure E-24 displays the speeds reported by the tourist group when presented with sign 3. The median was lower for the bilingual sign. On average, the tourists would travel slower upon presented with a bilingual sign than they would had the monolingual version been used instead. The speeds recorded ranged from 28mph (45km/h) to 70mph for the monolingual sign and 20mph to 70mph for the bilingual sign.

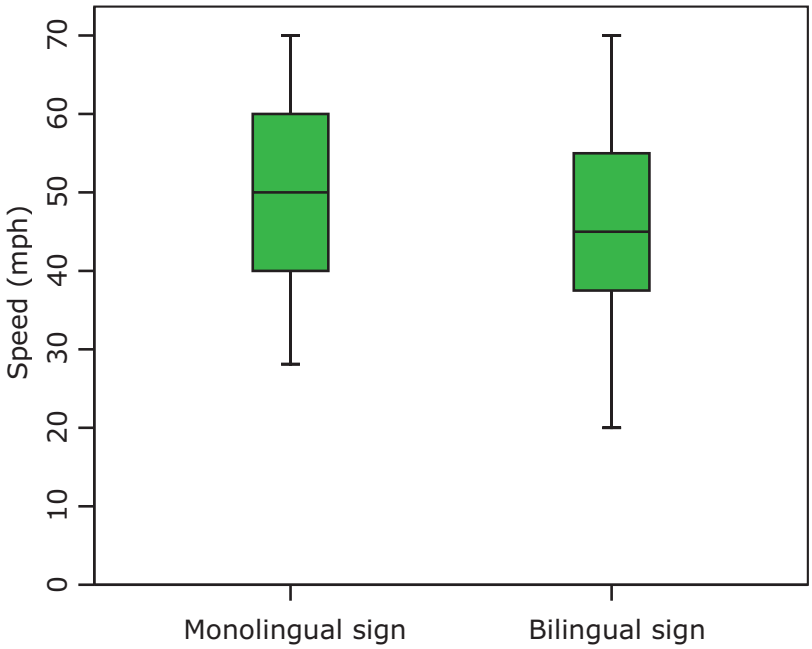


Figure E-24: Boxplot of tourist participants self-reported speeds for monolingual and bilingual sign 3

A Wilcoxon test on the weighted data showed that the speed recorded by tourists for the monolingual sign was significantly different from the speed reported for the bilingual sign ($p<0.01$).

E.4.1.4 Sign 4

Non-Gaelic

The median displayed for the monolingual and bilingual sign in Figure E-25 is the same. There is also little change in the size or shape of the interquartile range suggesting that the speeds recorded for the monolingual and bilingual version of the sign did not differ much. The lower range is 10mph less for the bilingual sign.

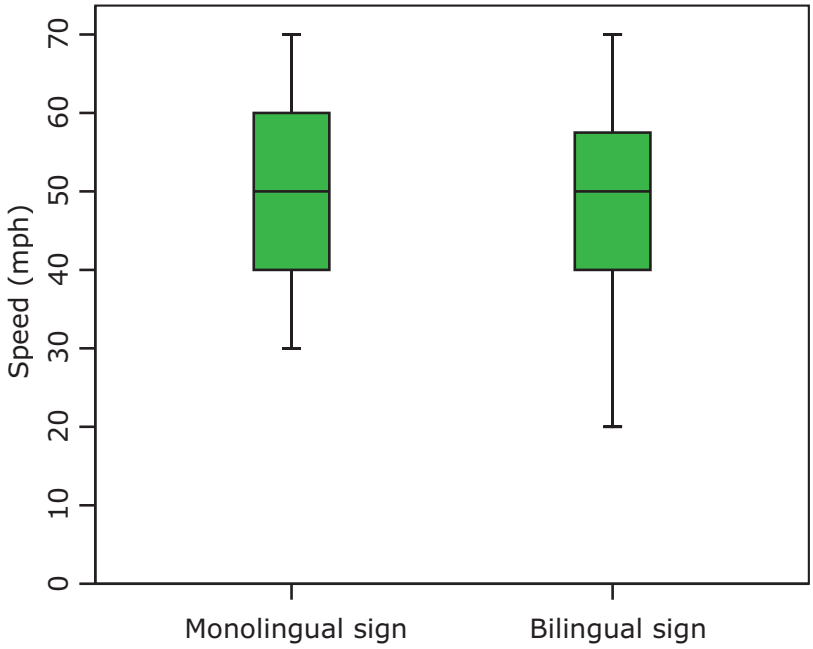


Figure E-25: Boxplot of Non-Gaelic participants self-reported speeds for monolingual and bilingual sign 4

A Wilcoxon test on the weighted data showed that the speed recorded by the Non-Gaelic group for the monolingual sign was significantly different from the speed reported for the bilingual sign ($p<0.01$).

Gaelic

The boxplots displayed for the monolingual and bilingual sign in Figure E-26 are identical in size, shape and range apart from the one speed (20mph) which was much lower than the rest of the answers and considered an outlier. This symmetry between the two plots suggests the speeds driven by the Gaelic participants would not change depending on the type of sign installed.

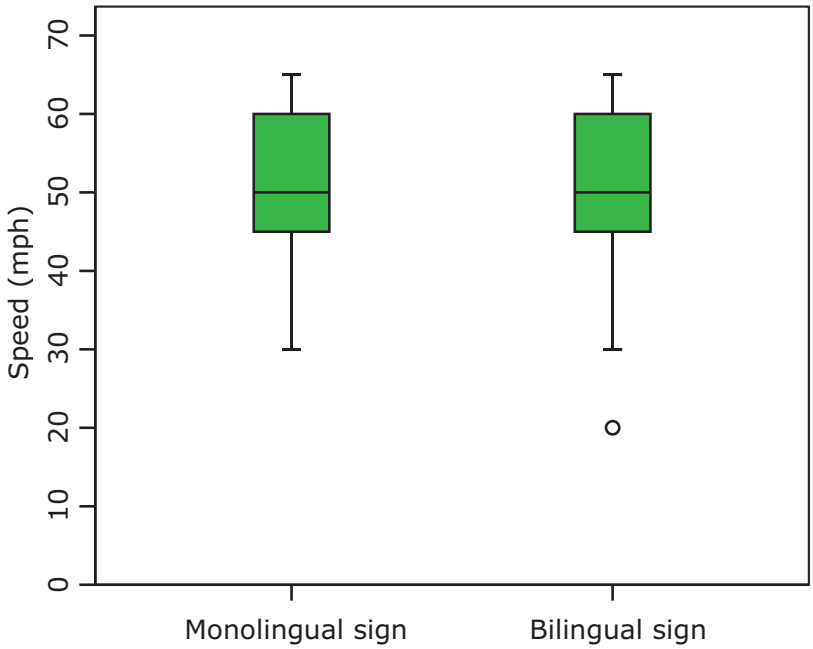


Figure E-26: Boxplot of Gaelic participants self-reported speeds for monolingual and bilingual sign 4

A Wilcoxon test on the weighted data showed that the speed recorded by the Gaelic group for the monolingual sign was significantly different from the speed reported for the bilingual sign ($p<0.05$).

Tourists

The results of the speed question for sign 4 are shown in Figure E-27. The median reduced by 10mph from the monolingual to bilingual sign; on average tourists would travel slower along a road with a bilingual sign installed than they would with an ordinary sign.

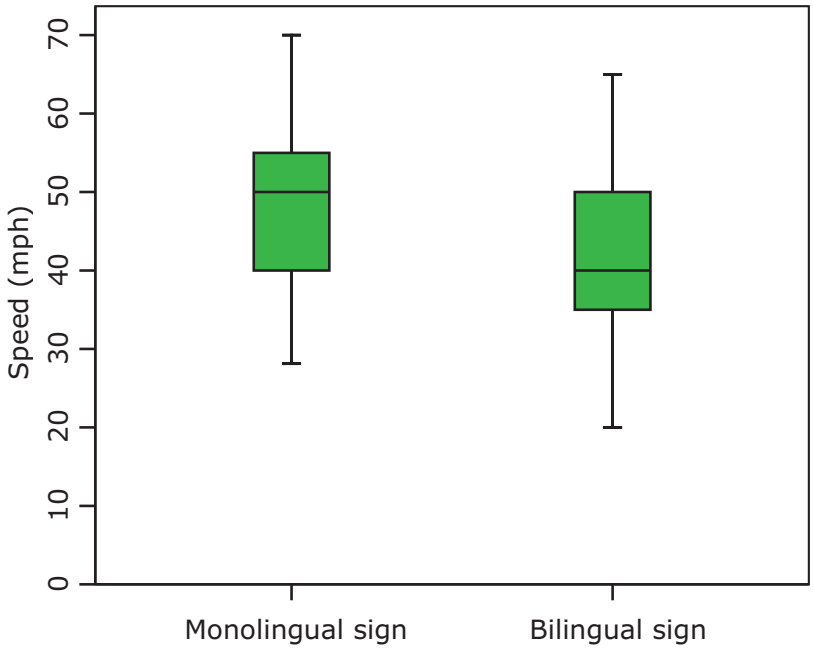


Figure E-26: Boxplot of Non-Gaelic participants self-reported speeds for monolingual and bilingual sign 4

A Wilcoxon test on the weighted data showed that the speed recorded by tourists for the monolingual sign was significantly different from the speed reported for the bilingual sign ($p<0.01$).

E.4.2 Question 2: Is there a difference between Gaelic and Non-Gaelic responses?

E.4.2.1 Sign 1

Monolingual sign

See left hand side of Figure E-21 and Figure E-22 for boxplot.

A Mann-Whitney U test on the weighted data showed that there was not a significant difference ($p>0.1$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Bilingual sign

See right hand side of Figure E-21 and Figure E-22 for boxplot.

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.05$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Difference between monolingual and bilingual sign

Changes in responses between monolingual and bilingual sign 1 are calculated by subtracting the speed reported for the bilingual sign from the self-reported speed for the monolingual sign for each participant. Figure E-28 shows a boxplot of the distribution of these changes for the Gaelic and Non-Gaelic groups. The negative end of the scale relates to participants who reported higher speeds on the bilingual route than the monolingual. A positive difference implies that the participants' speed would be lower on a bilingual route.

The median value recorded for the change in reported speed was 0 for both groups. For the Gaelic group, the upper and lower quartile (between them representing the middle 50%) were also 0 and hence, any change in the speed recorded (whether it be positive or negative) was considered as an anomaly; the Gaelic group would travel at the same speed regardless of the sign type displayed. The Non-Gaelic group on the other hand record more of a change in the speed from monolingual to bilingual sign route. The range and quartiles show that the amongst the Non-Gaelic responses both a reduction and an increase in speed was shown when the bilingual was compared to the monolingual. The upper quartile is different to the median showing that more people reduced the self-reported speed for the bilingual sign than increased it.

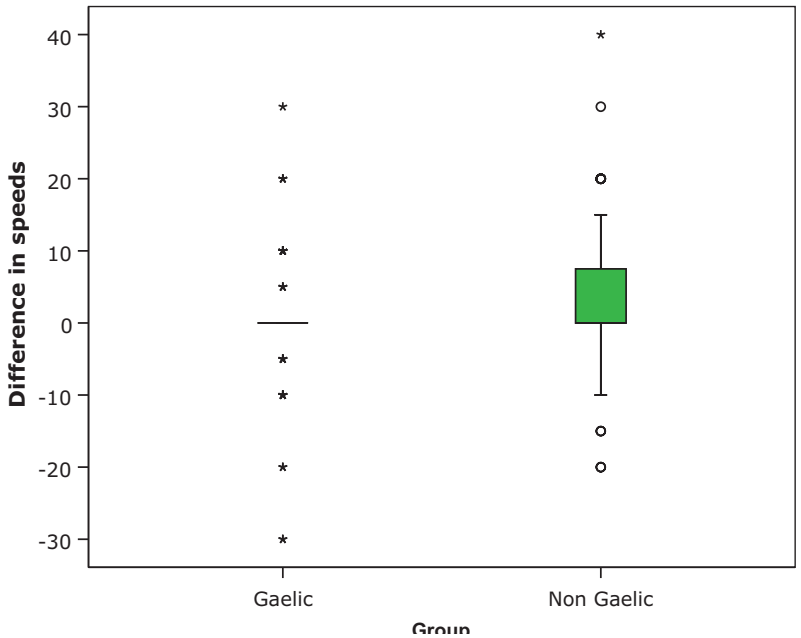


Figure E-28: Boxplot of differences between self-reported speeds for monolingual and bilingual sign 1 for the Gaelic and Non-Gaelic group

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of differences between the two speeds reported by the Gaelic and Non-Gaelic groups. Those in the Non-Gaelic group tend to record lower scores for the bilingual sign than the monolingual whereas the changes in the scores for the members of the monolingual sign are much smaller.

E.4.2.2 Sign 2

Monolingual sign

See left hand side of Figure E-24 and Figure E-25 for boxplot.

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Bilingual sign

See right hand side of Figure E-24 and Figure E-25 for boxplot.

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Difference between monolingual and bilingual sign

The difference between the speed recorded for the monolingual sign and that recorded for the bilingual sign is calculated for each individual in the Gaelic and Non-Gaelic group. The distribution of these differences is recorded in Figure E-29.

The median change in speed recorded for both groups is 0; on average neither group changed their reported speed from the monolingual to bilingual sign. Of those who did change their speed, the changes ranged from 20 to -10 for the Gaelic group and 30 to -25 for the Non-Gaelic.

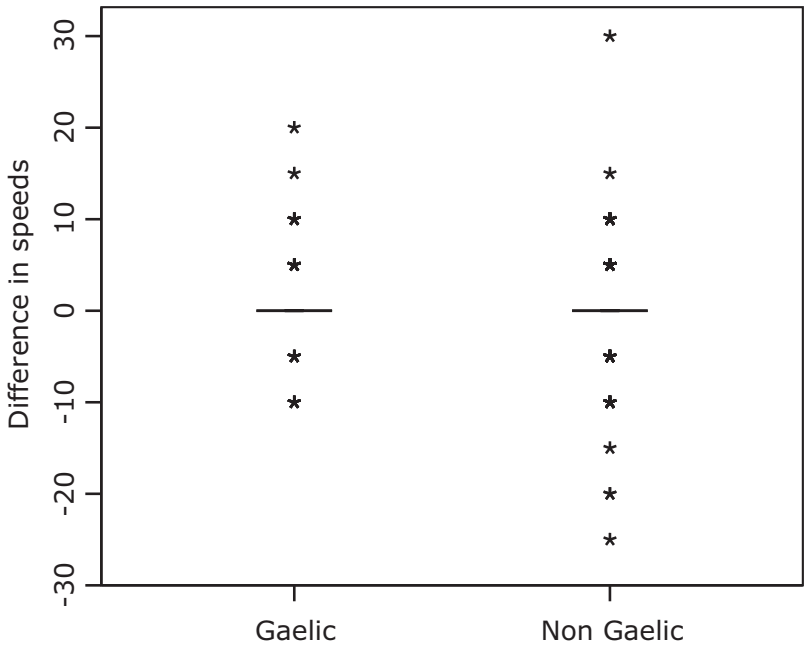


Figure E-29: Boxplot of differences between self-reported speeds for monolingual and bilingual sign 2 for the Gaelic and Non-Gaelic group

A Mann-Whitney U test on the weighted data showed that there was not a significant difference ($p>0.1$) in the distribution of differences between the two speeds reported by the Gaelic and Non-Gaelic groups.

E.4.2.3 Sign 3

Monolingual sign

See left hand side of Figure E-27 and Figure E-28 for boxplot.

A Mann-Whitney U test on the weighted data showed that there was not a significant difference ($p>0.1$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Bilingual sign

See right hand side of Figure E-27 and Figure E-28 for boxplot.

A Mann-Whitney U test on the weighted data showed that there was not a significant difference ($p>0.1$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Difference between monolingual and bilingual sign

Figure E-30 shows the difference between each of the self-reported speeds on the monolingual and bilingual sign route for Gaelic and Non-Gaelic participants.

The median for both groups is 0; the participants in the Gaelic and Non-Gaelic groups did not, on average, change the speeds recorded from the monolingual to bilingual sign. The median and quartiles both fall at 0 for the Gaelic group; the majority of this group show no change in reported speeds whereas, the Non-Gaelic group show a greater difference. The upper quartile shows that when arranged in order, the 50^{th} to 75^{th} percentile contains positive scores. These scores represent occasions where, for the

bilingual sign, the speed reported was lower than that of the monolingual. Both groups showed a range of changes in the speed with the Non-Gaelic group recording less occasions where the bilingual sign seemed to increase the speed.

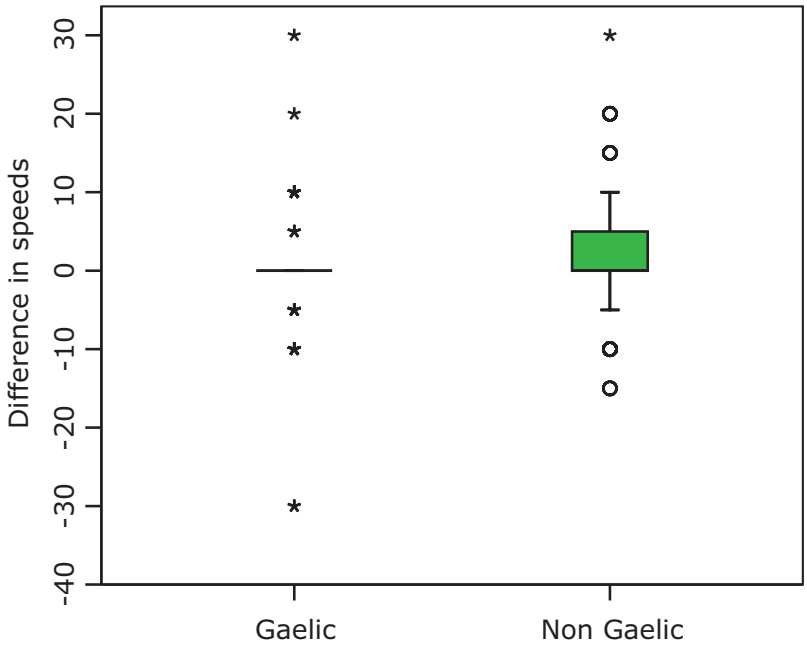


Figure E-30: Boxplot of differences between self-reported speeds for monolingual and bilingual sign 3 for the Gaelic and Non-Gaelic group

A Mann-Whitney U test on the weighted data showed that there was not a significant difference ($p>0.1$) in the distribution of differences between the two speeds reported by the Gaelic and Non-Gaelic groups.

E.4.2.4 Sign 4

Monolingual sign

See left hand side of Figure E-30 and Figure E-31 for boxplot.

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.05$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Bilingual sign

See right hand side of Figure E-30 and Figure E-31 for boxplot.

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Difference between monolingual and bilingual sign

The difference between the speeds reported for the monolingual and bilingual sign is demonstrated in the boxplot in Figure E-31. The medians for both groups (0) show that there is on average no difference between the speed recorded by one person for the monolingual and bilingual sign. The Non-Gaelic group has a wider range than the Gaelic group showing that their responses show more of a change. The majority of differences

fall in the positive part of the scale; the speed recorded on the bilingual route was lower than the corresponding persons speed on the monolingual route.

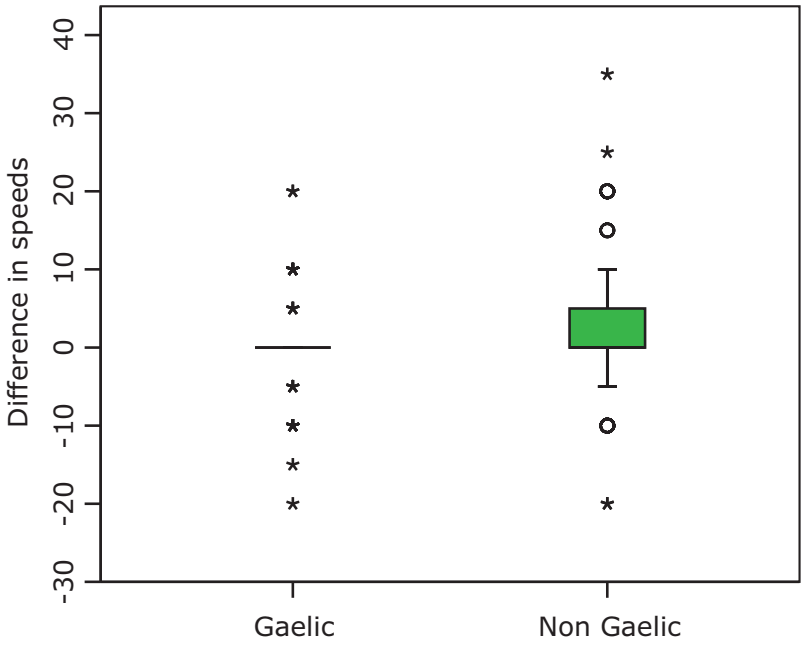


Figure E-31: Boxplot of differences between self-reported speeds for monolingual and bilingual sign 4 for the Gaelic and Non-Gaelic group

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.05$) in the distribution of differences between the two speeds reported by the Gaelic and Non-Gaelic groups. Those in the Non-Gaelic group tend to record lower scores for the bilingual sign than the monolingual whereas the changes in the scores for the members of the monolingual sign are much smaller.

E.5 Do you think this sign makes the scene less or more attractive?

E.5.1 Question 1: Is there a difference in rating between the monolingual and bilingual signs?

E.5.1.1 Sign 1

Non-Gaelic

Table E-16 shows the distribution of respondents' scores when asked to rate whether the sign makes the scene more or less attractive. The scale is defined from -3 (less) to 3 (more). Highlighted in the table is the proportion of participants who rated the scene with the bilingual sign as more attractive than the scene with the monolingual sign (yellow) and those who rated the monolingual sign scene more attractive than the scene with the bilingual sign (green).

Of the Non-Gaelic participants, 9% rated the bilingual scene as more attractive and 43% scored the scene with the monolingual scene higher.

Table E-16: Distribution of Non-Gaelic's paired scores for monolingual and bilingual sign 1

		Bilingual							Total
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**	
Monolingual	**-3**	1%							*1%*
	-2		1%	1%	1%	1%		1%	*3%*
	-1			5%	2%	1%			*9%*
	0	2%	1%	6%	30%	1%	1%		*40%*
	1	1%	1%	5%	9%	9%			*24%*
	2	1%	2%	2%	5%	4%	2%	1%	*16%*
	3	1%	1%	2%	1%	1%	2%	1%	*7%*
Total		*4%*	*5%*	*20%*	*48%*	*16%*	*5%*	*2%*	*100%*

*Green cells: monolingual sign is more attractive than the bilingual sign
*Yellow cells: bilingual sign is more attractive than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

By examining the totals we can conclude that a higher proportion of the Non-Gaelic group thought that the bilingual sign did not alter the attractiveness of the scene (score of 0) than the monolingual sign. A bigger proportion of the group thought the monolingual sign improved the attractiveness of the scene (1-3) than the bilingual sign.

A Wilcoxon test on the weighted data showed that the Non-Gaelic group found the scene with the monolingual sign significantly more attractive than the bilingual sign scene ($p<0.01$).

Gaelic

The distribution of the Gaelic group's responses to the question relating to the attractiveness of the scene with a monolingual and bilingual sign is shown in Table E-17.

Amongst the Gaelic group a slightly higher proportion of people (20%) rated the scene with the bilingual sign as more attractive than the monolingual equivalent (yellow section). This is compared to 18% who thought that the monolingual was more attractive than the bilingual.

Table E-17: Distribution of Gaelic's paired scores for monolingual and bilingual sign 1

		Bilingual							*Total*
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**	
Monolingual	**-3**	1%	1%						*2%*
	-2		5%	2%			1%		*8%*
	-1	1%		8%	3%	1%			*13%*
	0	1%	1%	2%	37%	6%		1%	*48%*
	1			1%	3%	5%	2%		*11%*
	2			1%	4%	3%	5%	3%	*16%*
	3				1%			2%	*3%*
Total		*3%*	*7%*	*14%*	*48%*	*15%*	*8%*	*6%*	*100%*

*Green cells: monolingual sign is more attractive than the bilingual sign
*Yellow cells: bilingual sign is more attractive than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

Forty-eight percent of the scores from the Gaelic group recorded that the sign did not change the attractiveness of the scene for both the monolingual and bilingual sign. The responses for the monolingual and bilingual signs seem to be fairly similarly distributed.

A Wilcoxon test on the weighted data showed that the Gaelic group did not find either scene significantly more attractive than the other ($p>0.1$). The mean attractiveness rating for the bilingual sign was slightly less when compared to the mean rating given for the monolingual; the Gaelic group found the scene with the bilingual sign slightly less attractive.

Tourists

As shown in Table E-18, 46% of tourists scored the scene with the monolingual sign as more attractive than the bilingual sign scene. Only 6% thought the bilingual scene was more attractive.

Table E-18: Distribution of Tourist's paired scores for monolingual and bilingual sign 1

		Bilingual							*Total*
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**	
Monolingual	**-3**								*0%*
	-2	1%	1%						*2%*
	-1	1%		6%	1%				*8%*
	0		1%	4%	33%	3%			*41%*
	1	1%	1%	6%	11%	6%	1%	1%	*26%*
	2	3%	1%	2%	6%	1%	2%		*16%*
	3	1%	1%	1%	3%	1%		1%	*8%*
Total		*6%*	*5%*	*18%*	*55%*	*12%*	*3%*	*1%*	*100%*

*Green cells: monolingual sign is more attractive than the bilingual sign
*Yellow cells: bilingual sign is more attractive than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

By examining the total proportion for each score in Table E-18 we can see that more tourists believe the bilingual sign has a negative impact on the attractiveness of the scene (score -3 to -1) than the monolingual sign.

A Wilcoxon test on the weighted data showed that the tourist group found the scene with the monolingual sign significantly more attractive than the bilingual sign scene ($p<0.01$).

E.5.1.2 Sign 2

Non-Gaelic

Table E-19 shows the distribution of scores given by the Non-Gaelic group to the attractiveness of the scene with both the monolingual and bilingual signs.

A small proportion, 7% of the Non-Gaelic participants rated the scene with the bilingual sign more attractive than the monolingual sign. Conversely, 49% rated the monolingual sign as more attractive than the bilingual.

TableF-19: Distribution of Non-Gaelic's paired scores for monolingual and bilingual sign 2

		Bilingual							*Total*
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**	
Monolingual	**-3**	1%							*1%*
	-2		2%	1%	1%				*4%*
	-1	1%	1%	3%	2%	1%			*9%*
	0	1%	7%	6%	30%		1%		*44%*
	1	1%	2%	4%	7%	5%	1%		*20%*
	2	1%	2%	2%	3%	2%	3%	1%	*14%*
	3	1%	2%	2%	2%	1%	2%		*9%*
Total		*5%*	*15%*	*18%*	*47%*	*9%*	*6%*	*1%*	*100%*

*Green cells: monolingual sign is more attractive than the bilingual sign
*Yellow cells: bilingual sign is more attractive than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

The majority of the Non-Gaelic group rated the bilingual as having no effect or a negative effect (scores -3 to 0) on attractiveness of the scene whilst for the monolingual scene, most of the scores were 0 to 2 indicating that they thought the monolingual sign had no effect or in fact improved the attractiveness of the scene.

A Wilcoxon test on the weighted data showed that the Non-Gaelic group found the scene with the monolingual sign significantly more attractive than the bilingual sign scene ($p<0.01$).

Gaelic

The distribution of scores for the Gaelic group when judging the attractiveness of both monolingual and bilingual sign 3 is recorded in Table E-20.

12% of the group rated the bilingual sign as higher on the scale than the equivalent monolingual scene. 17% believed that the monolingual scene was more attractive than the bilingual. 71% of the Gaelic group rated the attractiveness of the scene as the same for both the Gaelic and Non-Gaelic group.

Table E-20: Distribution of Gaelic's paired scores for monolingual and bilingual sign 2

		Bilingual							*Total*
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**	
Monolingual	**-3**	1%							*1%*
	-2	1%	8%	2%		1%			*12%*
	-1	1%	3%	8%	2%				*14%*
	0	1%		4%	39%	2%	3%		*49%*
	1				4%	7%		1%	*12%*
	2				1%	1%	5%	1%	*8%*
	3						1%	3%	*4%*
Total		*4%*	*11%*	*14%*	*46%*	*11%*	*9%*	*5%*	*100%*

*Green cells: monolingual sign is more attractive than the bilingual sign
*Yellow cells: bilingual sign is more attractive than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

The distribution of scores across the scale from -3 to 3 is similar for both the monolingual and bilingual signs. 39% of the Gaelic group thought that neither the monolingual or bilingual sign had an impact on the attractiveness of the scene (rating of 0).

A Wilcoxon test on the weighted data showed that the Gaelic group did not find either scene significantly more attractive than the other ($p>0.1$). The mean attractiveness rating for the bilingual sign was the same as the rating given for the monolingual sign; on average the Gaelic group found no difference in the attractiveness of the scene with the monolingual or bilingual sign in place.

Tourists

Table E-21 shows the distribution of scores given by the tourists for the attractiveness of scene with both the monolingual and bilingual sign.

Just under half (49%) of the tourist group rated the scene with the monolingual sign to be more attractive than the scene with the bilingual sign. Only 6% of the tourists felt that the bilingual sign scene was more attractive than the monolingual version.

Table E-21: Distribution of Tourist's paired scores for monolingual and bilingual sign 2

		Bilingual							*Total*
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**	
Monolingual	**-3**								*0%*
	-2	1%	2%	1%					*3%*
	-1		2%	7%	1%	1%			*12%*
	0		5%	6%	32%	1%			*44%*
	1	1%	1%	2%	10%	2%	1%		*17%*
	2	2%	2%	3%	4%	4%	1%	1%	*17%*
	3	1%	1%	1%	2%	1%		1%	*7%*
Total		*5%*	*14%*	*20%*	*49%*	*10%*	*2%*	*1%*	*100%*

*Green cells: monolingual sign is more attractive than the bilingual sign
*Yellow cells: bilingual sign is more attractive than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

For both signs the majority of the tourist group rated the attractiveness of the scene as 0; the attractiveness of the scene is not affected by the scene. More of the scores for the bilingual sign were negative than the scene with the monolingual sign.

A Wilcoxon test on the weighted data showed that the tourist group found the scene with the monolingual sign significantly more attractive than the bilingual sign scene ($p<0.01$).

E.5.1.3 Sign 3

Non-Gaelic

The scores for sign 3 by Non-Gaelic participants are displayed in Table E-22; 5% of the responses implied the bilingual sign was considered more attractive. On the other hand, 48% believed the monolingual sign scene was more attractive.

Table E-22: Distribution of Non-Gaelic's paired scores for monolingual and bilingual sign 3

		Bilingual							*Total*
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**	
Monolingual	**-3**	1%							*1%*
	-2		2%		1%				*2%*
	-1	1%	1%	5%	1%	1%			*7%*
	0	1%	2%	7%	30%	2%	1%		*42%*
	1	1%	2%	6%	11%	6%	1%		*26%*
	2	1%	1%	1%	2%	2%	3%	1%	*12%*
	3	1%	1%	3%	2%	1%	2%	1%	*10%*
Total		*5%*	*9%*	*22%*	*46%*	*11%*	*6%*	*1%*	*100%*

*Green cells: monolingual sign is more attractive than the bilingual sign
*Yellow cells: bilingual sign is more attractive than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

More Non-Gaelic participants rated the monolingual sign between 0 and 3; the sign had no effect or made the scene more attractive, than rated the bilingual sign between these scores. This suggests that the Non-Gaelic readers find the monolingual sign more attractive.

A Wilcoxon test on the weighted data showed that the Non-Gaelic group found the scene with the monolingual sign significantly more attractive than the bilingual sign scene ($p<0.01$).

Gaelic

12% of the Gaelic group reported that the attractiveness of the scene was greater with the bilingual sign in place than the monolingual (see Table E-23). Conversely, 18% scored the monolingual sign as more attractive.

Table E-23: Distribution of Gaelic's paired scores for monolingual and bilingual sign 3

		Bilingual							*Total*
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**	
Monolingual	**-3**	2%							*2%*
	-2	1%	6%	3%					*10%*
	-1		2%	5%	2%				*9%*
	0	1%		4%	43%	2%	1%		*50%*
	1				4%	7%	3%		*14%*
	2			1%		1%	6%	1%	*9%*
	3					1%	3%	2%	*6%*
Total		*4%*	*8%*	*13%*	*49%*	*11%*	*13%*	*3%*	*100%*

*Green cells: monolingual sign is more attractive than the bilingual sign
*Yellow cells: bilingual sign is more attractive than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

The total proportion for each score is fairly similarly distributed for the monolingual and bilingual signs. The high proportion of people (70%) who scored sign 3 the same on the rating of attractiveness for the monolingual and bilingual sign shows that Gaelic people feel the bilingual nature of the sign does not change the amount which a sign affects the appearance of the scene.

A Wilcoxon test on the weighted data showed that the Gaelic group did not find either scene significantly more attractive than the other ($p>0.1$).

Tourists

The distribution of scores by tourists for the attractiveness of the scene is shown in Table E-24. Nearly half of the tourist participants rated the monolingual sign as more attractive than the bilingual. Only 7% felt the opposite; the bilingual sign was more attractive.

Table E-24: Distribution of Tourist's paired scores for monolingual and bilingual sign 3

		Bilingual							*Total*
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**	
Monolingual	**-3**								
	-2	1%	1%						*1%*
	-1		1%	6%	1%				*8%*
	0		1%	5%	31%	3%			*41%*
	1	1%	1%	3%	12%	6%	2%		*25%*
	2	2%	2%	4%	4%	2%	1%	1%	*16%*
	3	2%	1%	2%	2%	1%		1%	*9%*
Total		*6%*	*7%*	*19%*	*51%*	*12%*	*3%*	*1%*	*100%*

*Green cells: monolingual sign is more attractive than the bilingual sign
*Yellow cells: bilingual sign is more attractive than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

Over half (51%) of the tourists felt that the bilingual sign had no impact on the attractiveness of the scene (score of 0) whilst only 41% felt the monolingual had no effect. A large proportion of the scores for the monolingual sign were 1 to 3 showing that the tourists felt that the monolingual sign actually improved the attractiveness of the scene.

A Wilcoxon test on the weighted data showed that the tourist group found the scene with the monolingual sign significantly more attractive than the bilingual sign scene ($p<0.01$).

E.5.1.4 Sign 4

Non-Gaelic

Table E-25 shows the scores obtained from the Non-Gaelic respondents. The large proportion of responses which fall into the green section (49%) illustrates the large quantity of people that rated the scene with the monolingual sign as more attractive than the bilingual.

Table E-25: Distribution of Non-Gaelic's paired scores for monolingual and bilingual sign 4

		Bilingual							*Total*
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**	
Monolingual	**-3**	1%							*1%*
	-2		1%						*1%*
	-1	1%		4%	1%	2%			*7%*
	0	1%	2%	6%	30%	2%	1%		*41%*
	1		1%	6%	10%	6%	1%		*23%*
	2	1%	2%	2%	3%	2%	3%		*12%*
	3	1%	3%	4%	3%	1%	2%	1%	*15%*
Total		*3%*	*9%*	*22%*	*47%*	*13%*	*6%*	*1%*	*100%*

*Green cells: monolingual sign is more attractive than the bilingual sign
*Yellow cells: bilingual sign is more attractive than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

Thirty-four percent of the Non-Gaelic group scored the bilingual sign -3 to -1 implying that the sign had a negative impact on the attractiveness of the scene. Only 9% of the same group of people rated the monolingual sign as having a negative impact on the attractiveness of the scene.

A Wilcoxon test on the weighted data showed that the Non-Gaelic group found the scene with the monolingual sign significantly more attractive than the bilingual sign scene ($p<0.01$).

Gaelic

71% of the Gaelic group rated the attractiveness of the scene with monolingual and bilingual sign as the same; 43% felt that neither sign detracted or improved the appearance of the scene. The distribution of people who felt that the bilingual sign was more attractive (15%) was very similar to the distribution of individuals who scored the monolingual sign better (14%).

Table E-26: Distribution of Gaelic's paired scores for monolingual and bilingual sign 4

		Bilingual							*Total*
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**	
Monolingual	**-3**	1%							*1%*
	-2		4%	3%					*7%*
	-1		2%	9%	2%	1%			*14%*
	0	1%		2%	43%	3%	2%	1%	*51%*
	1		1%		3%	6%	1%		*11%*
	2				1%	2%	6%	2%	*11%*
	3					1%	1%	3%	*5%*
Total		*2%*	*7%*	*14%*	*49%*	*13%*	*10%*	*6%*	*100%*

*Green cells: monolingual sign is more attractive than the bilingual sign
*Yellow cells: bilingual sign is more attractive than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

The percentage of the group which recorded each of the scores -3 to 3 for both signs are fairly similar; this suggests the group does not have a preference as to which sign they feel is more attractive.

A Wilcoxon test on the weighted data showed that the Gaelic group did not find either scene significantly more attractive than the other ($p>0.1$). The mean attractiveness rating for the bilingual sign was the same as the rating given for the monolingual sign; on average the Gaelic group found no difference in the attractiveness of the scene with the monolingual or bilingual sign in place.

Tourists

A very small proportion of the tourists' responses in Table E-27 suggests that they felt the scene with the bilingual sign was more attractive. On the other hand, 45% rated the monolingual sign higher on the scale than bilingual sign 4.

Table E-27: Distribution of Tourist's paired scores for monolingual and bilingual sign 4

		Bilingual							*Total*
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**	
Monolingual	**-3**								*0%*
	-2	1%	1%						*1%*
	-1		1%	6%	1%	1%			*8%*
	0		2%	4%	32%	2%			*41%*
	1	1%	1%	2%	13%	7%	1%		*26%*
	2	2%	3%	1%	4%	1%	2%	1%	*15%*
	3	1%	1%	2%	2%	1%		1%	*9%*
Total		*6%*	*9%*	*15%*	*52%*	*13%*	*3%*	*2%*	*100%*

*Green cells: monolingual sign is more attractive than the bilingual sign
*Yellow cells: bilingual sign is more attractive than the monolingual sign
Sums of row and column data may not add up to the specified totals due to rounding.

No one in the tourist group rated the scene with the monolingual sign as much less attractive (score of -3) whereas 6% of people rated the bilingual sign with this score. Tourists appear to have a more positive feeling about the attractiveness of the monolingual sign than the bilingual.

A Wilcoxon test on the weighted data showed that the tourist group found the scene with the monolingual sign significantly more attractive than the bilingual sign scene ($p<0.01$).

E.5.2 Question 2: Is there a difference between Gaelic and Non-Gaelic responses?

E.5.2.1 Sign 1

Monolingual sign

Figure E-32 shows the distribution of scores given for the change in attractiveness of the scene with the monolingual sign by the Gaelic and Non-Gaelic groups. The scale is defined from -3 (less) to 3 (more). There is a higher proportion of the Gaelic group that rate the sign as 0; having no effect, or as -3 to -1; having a negative effect on the attractiveness, than the Non-Gaelic participants.

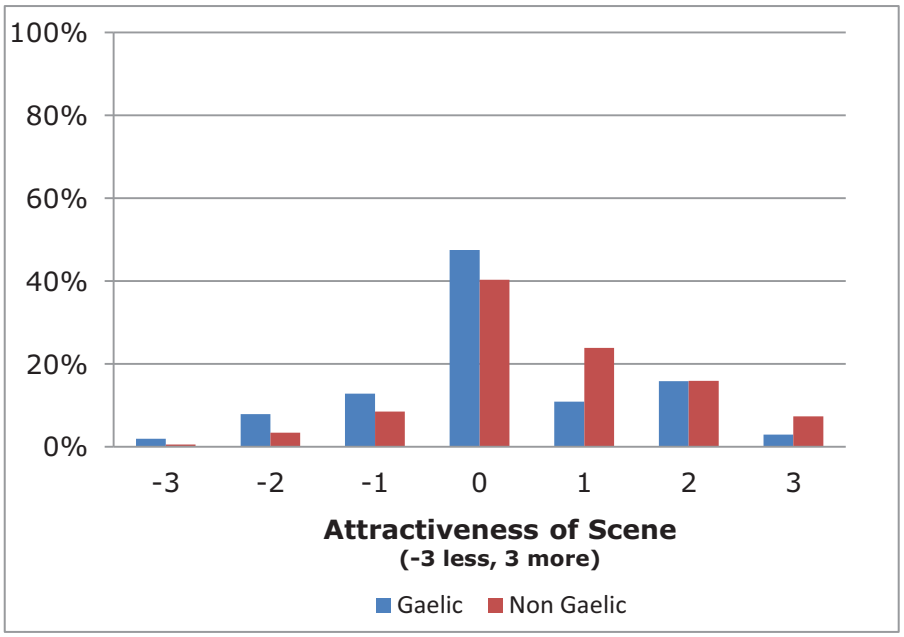


Figure E-32: Attractiveness of the scene with monolingual sign 1 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Bilingual sign

Figure E-33 compares the scores given by the Gaelic and Non-Gaelic group to the affect of the attractiveness of the scene with bilingual sign 1. The scores are fairly evenly distributed across the two groups, with slightly more of the Gaelic group feeling that the bilingual sign had a large positive effect (score of 2 or 3) on the attractiveness of the scene.

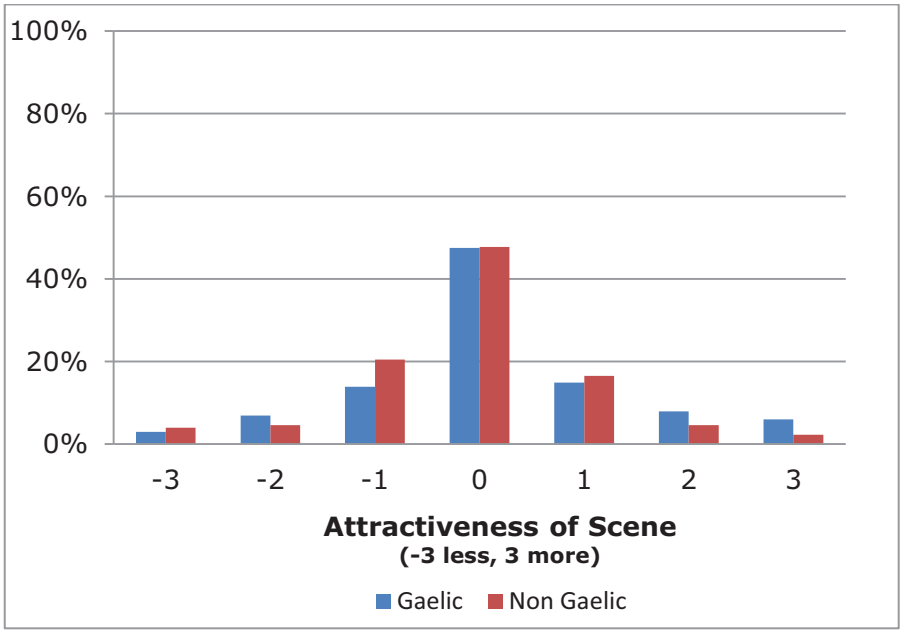


Figure E-33: Attractiveness of the scene with bilingual sign 1 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was not a significant difference ($p>0.1$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Difference between monolingual and bilingual sign

Changes in responses between the monolingual and bilingual sign 1 are calculated by subtracting the score given for the bilingual sign from the score for the monolingual sign for each participant. Figure E-34 shows the distribution of these changes for the Gaelic and Non-Gaelic groups. The scale runs from -6 (participants who rated the scene with the bilingual sign as more attractive by 6 points than the monolingual) to 6 (participants who rated the monolingual sign higher by 6 points).

Of those who give a different score to the bilingual and monolingual signs, participants in the Non-Gaelic group were most likely to score the monolingual sign one point higher than the bilingual sign, and participants in the Gaelic group were more likely to score bilingual signs one point higher than the monolingual sign.

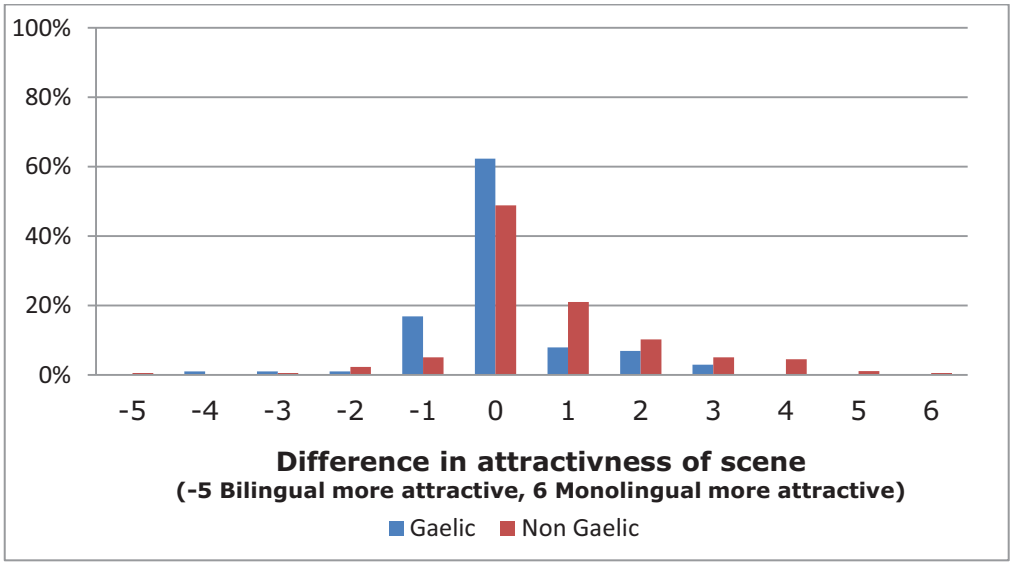


Figure E-34: Difference in attractiveness of scene with bilingual and monolingual sign 1 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

E.5.2.2 Sign 2

Monolingual sign

As shown in Figure E-35, a higher proportion of the Non-Gaelic group rate the monolingual sign as making the scene more attractive (1-3) than in the Gaelic group. Whereas, a higher percentage of the Gaelic group give negative scores when compared to those Non-Gaelic who score -3 to -1. This suggests that Non-Gaelic people like monolingual signs whereas the Gaelic group have a more negative view of them.

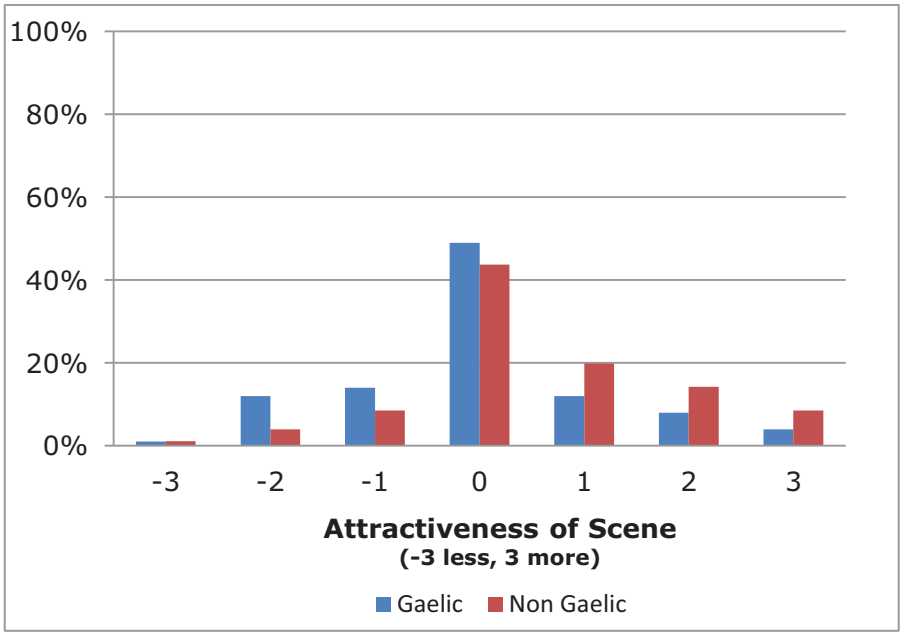


Figure E-35: Attractiveness of the scene with monolingual sign 2 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Bilingual sign

The pattern described in Figure E-35 has been reversed in Figure E-36: a higher proportion of the Gaelic group feel the bilingual sign has improved the attractiveness of the scene than the Non-Gaelic group. The majority of the Non-Gaelic group on the other hand, excluding those who rate the signs as the same, rate the scene as less attractive.

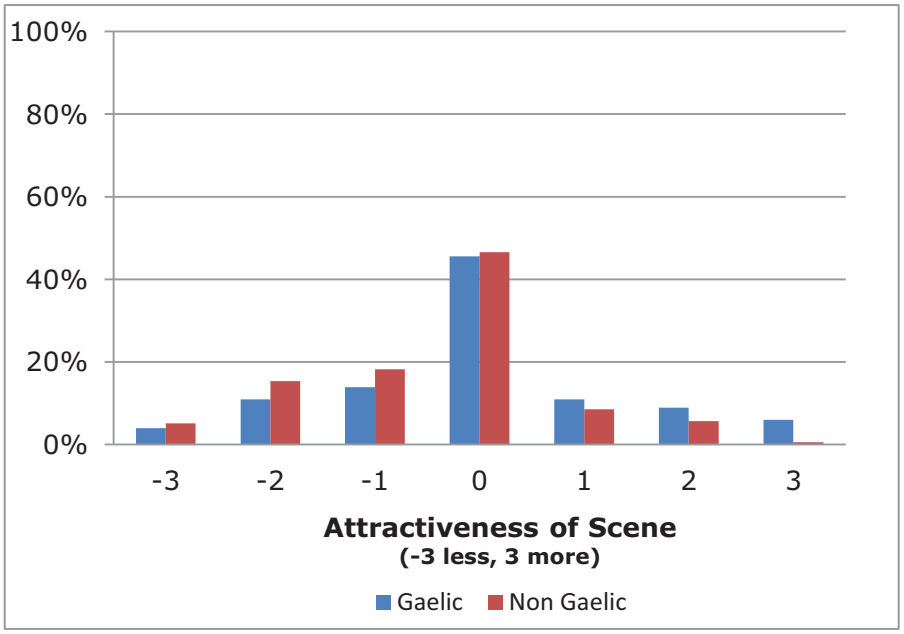


Figure E-36: Attractiveness of the scene with bilingual sign 2 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.05$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Difference between monolingual and bilingual sign

Figure E-37 shows the difference in the scores given for the change in attractiveness of the scene with the bilingual and monolingual signs for both the Gaelic and Non-Gaelic groups. The scores range from -3 (the bilingual sign is more attractive) to 6 (the monolingual sign rates 6 points higher on the scale).

A huge proportion (71%) of the Gaelic group does not change their scores from rating the attractiveness of the scene with the monolingual to the bilingual sign. Of the Non-Gaelic group who do not give a difference of 0 (do change their scores) most rate the monolingual scene higher than the bilingual.

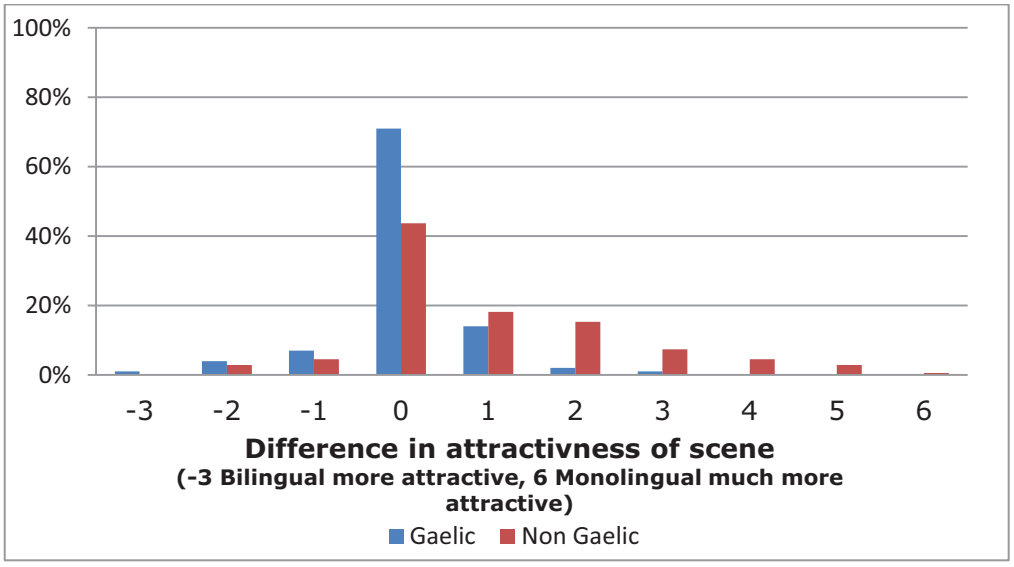


Figure E-37: Difference in attractiveness of scene with bilingual and monolingual sign 2 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

E.5.2.3 Sign 3

Monolingual sign

Figure E-38 shows the answers given to the question asking if the respondent thinks the monolingual sign makes the scene more or less attractive. A higher proportion of the Gaelic group think that the sign detracts from or has no effect on the attractiveness of the scene (-3 to 0) than the Non-Gaelic group.

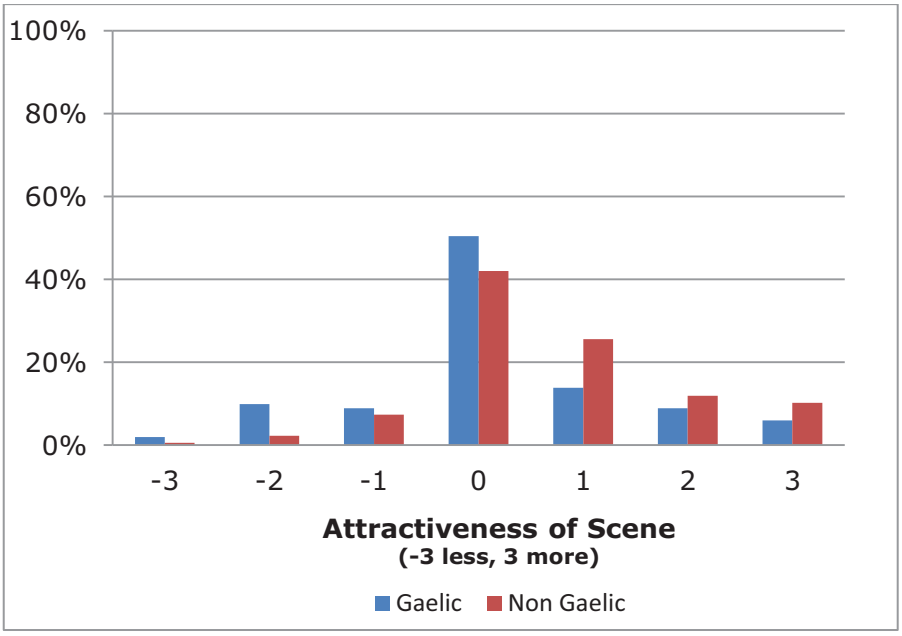


Figure E-38: Attractiveness of the scene with monolingual sign 3 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Bilingual sign

The responses given for the attractiveness of the scene with the bilingual sign by Gaelic and Non-Gaelic respondents are displayed in Figure E-39. A higher proportion of the Non-Gaelic respondents believed that the bilingual sign decreased the attractiveness of the scene than the Gaelic participants.

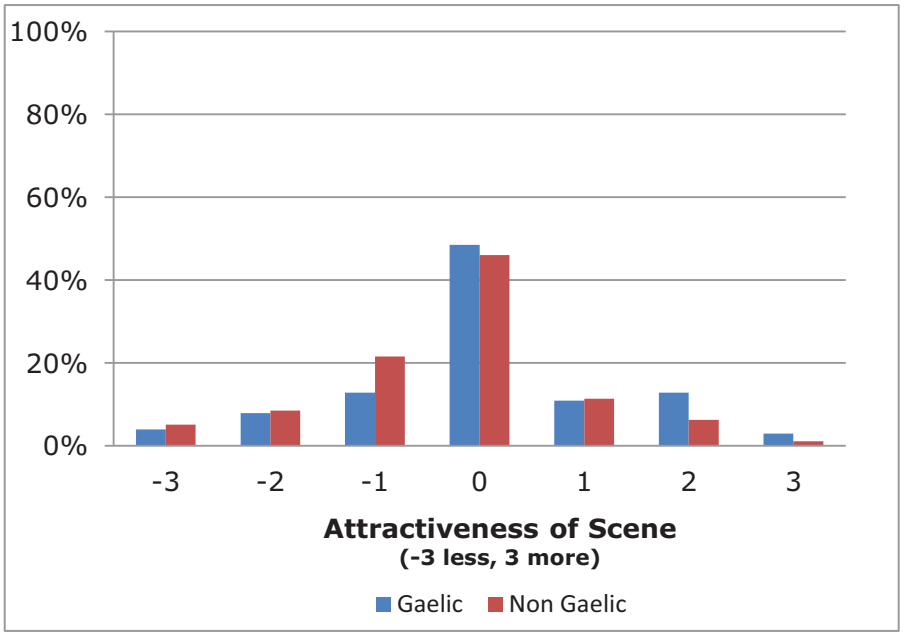


Figure E-39: Attractiveness of the scene with bilingual sign 3 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was not a significant difference ($p>0.05$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Difference between monolingual and bilingual sign

The distribution of the difference in scores between monolingual and bilingual sign 3 for the Gaelic and Non-Gaelic groups is displayed in Figure E-40. A score of -2 suggests that the participant believes the bilingual sign to be more attractive whilst a score of 6 means the monolingual sign rates 6 points higher on the scale than the bilingual.

48% of the Non-Gaelic group have a positive difference score (1 to 6) which means that they rated the monolingual sign higher on the scale of attractiveness. Only 17% of the difference in scores by the Gaelic group showed that this was the case.

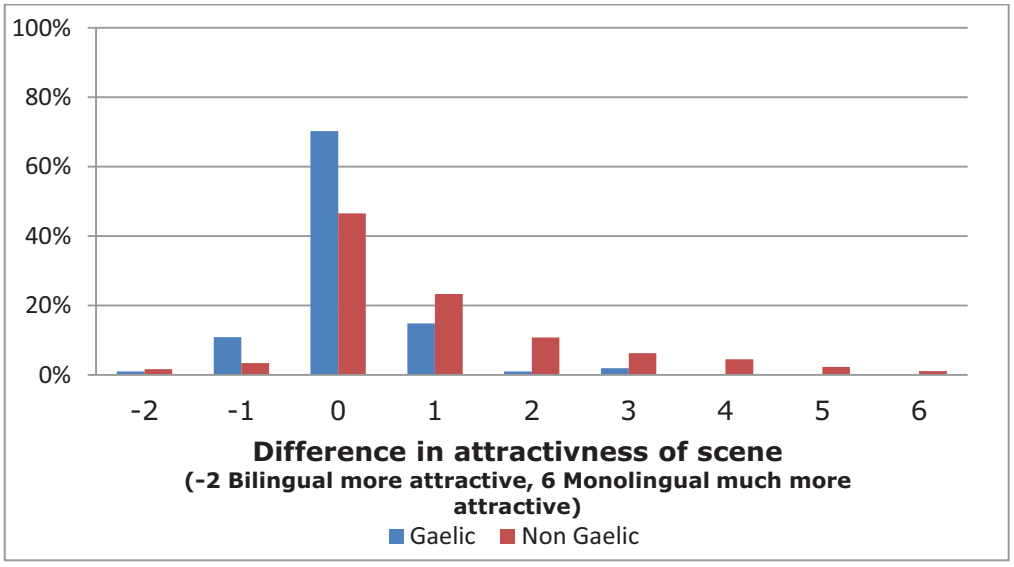


Figure E-40: Difference in attractiveness of scene with bilingual and monolingual sign 3 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

E.5.2.4 Sign 4

Monolingual sign

Figure E-41 shows the scores given by Gaelic and Non-Gaelic participants when responding whether they believe the monolingual sign makes the scene more or less attractive. A larger proportion of Gaelic people score the monolingual sign 0; the sign has no impact on the attractiveness of the scene, than the Non-Gaelic readers. For each of the scores 1 to 3 (the sign makes the scene more attractive) the Non-Gaelic group has a higher proportion of people giving these responses than the Gaelic.

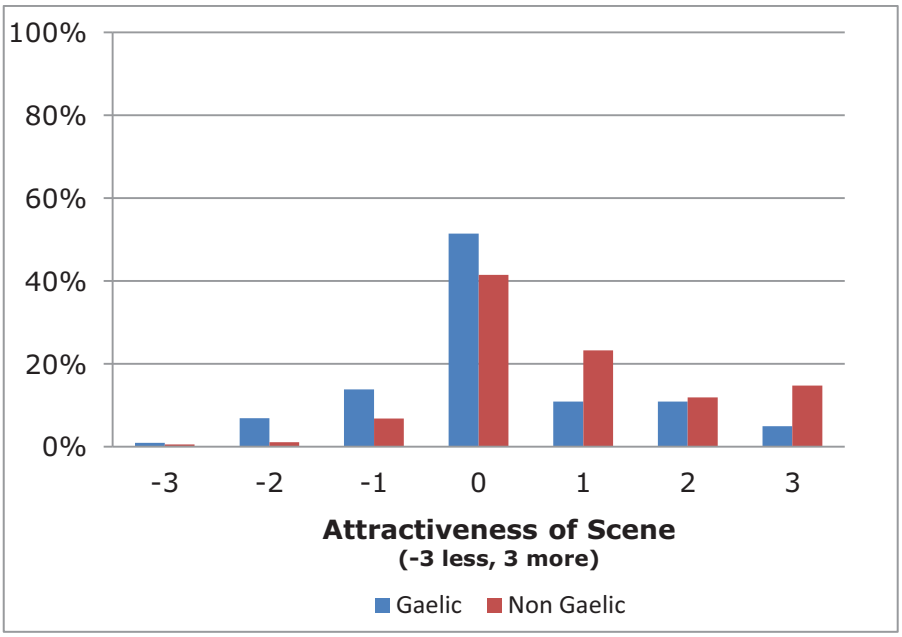


Figure E-41: Attractiveness of the scene with monolingual sign 4 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Bilingual sign

Similarly to the equivalent monolingual sign, a higher proportion of the Gaelic group think the bilingual sign has no effect on the attractiveness of the scene than the Non-Gaelic group. However, as shown in Figure E-42 the Non-Gaelic group have a larger percentage which believes the bilingual sign has a negative impact on the attractiveness of the scene than the Gaelic group.

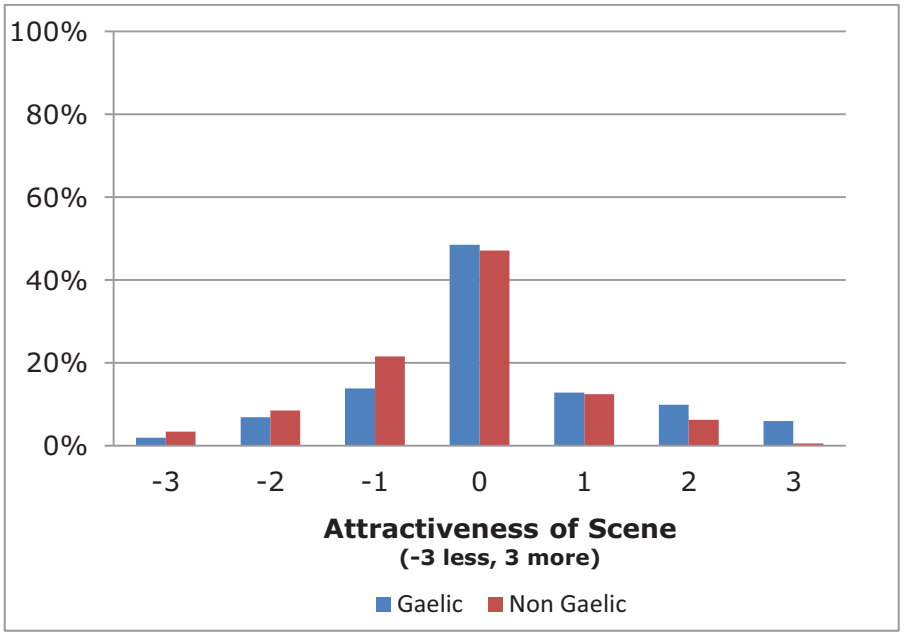


Figure E-42: Attractiveness of the scene with bilingual sign 4 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was not a significant difference ($p>0.05$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

Difference between monolingual and bilingual sign

Figure E-43 displays the difference in scores between the monolingual and bilingual sign. A score of -3 indicates that the bilingual sign rates 3 points more than the monolingual. A positive score (1-6) means that the monolingual sign has scored better.

The majority of the Gaelic group had a difference score of 0 indicating that their score was the same for the monolingual and bilingual sign; they felt that the type of sign did not change the amount which the sign affected the attractiveness of the scene. More of the Non-Gaelic group scored the monolingual sign higher than the bilingual.

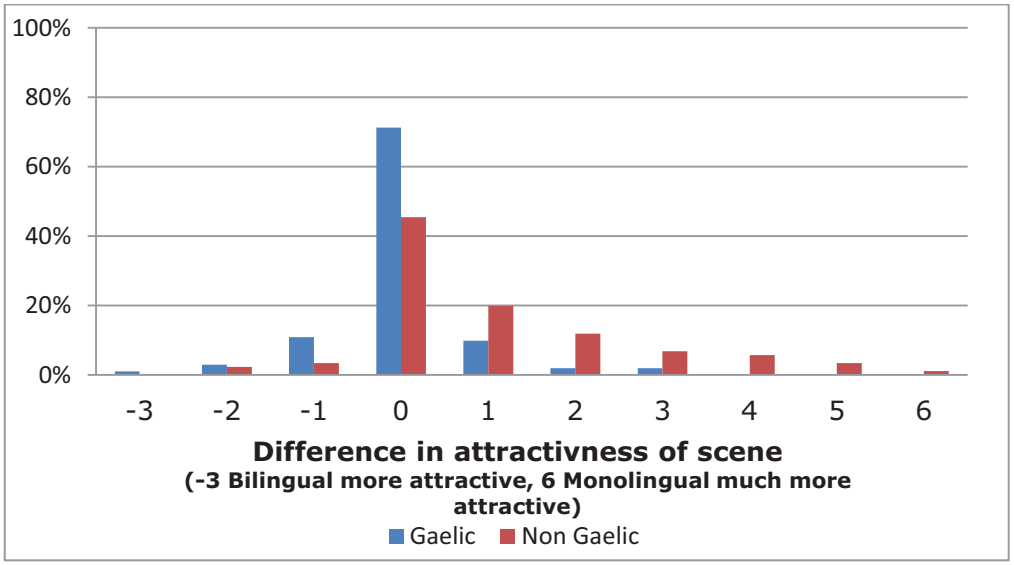


Figure E-43: Difference in attractiveness of scene with bilingual and monolingual sign 4 for Gaelic and Non-Gaelic participants

A Mann-Whitney U test on the weighted data showed that there was a significant difference ($p<0.01$) in the distribution of scores given by the Gaelic and Non-Gaelic groups.

E.6 General monolingual and bilingual signs

E.6.1 Is there a difference between the proportions of people who respond yes to safety statements for monolingual and bilingual signs?

To determine if there is a difference in the situations experienced with the monolingual and bilingual signs, a McNemar test is carried out on the responses to each of the statements in question A2 and the corresponding question in B2.

E.6.1.1 Statement A: I have had to slow down to read signs like these

Non-Gaelic

Table E-28 displays the count of the Non-Gaelic group's paired responses to the statement 'I have had to slow down to read signs like these' for the monolingual and bilingual sign. Very few people stated they had to slow down to read monolingual signs but did not to read the bilingual.

Table E-28: Count of paired responses by the Non-Gaelic group to the statement 'I have had to slow down to read signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	75	2
	No	74	25

There is a significant difference ($p<0.01$) between the answers given by Non-Gaelic readers to the statement 'I have had to slow down to read signs like these' for monolingual versus bilingual signs.

Gaelic

The number of Gaelic people who responded 'yes' or 'no' to the statement 'I have had to slow down to read road signs like these' is recorded in Table E-29. The majority of the Gaelic group responded 'yes' for both the monolingual and bilingual sign.

Table E-29: Count of paired responses by the Gaelic group to the statement 'I have had to slow down to read signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	59	4
	No	7	31

There is not a significant difference ($p>0.1$) between the answers given by Gaelic readers to the statement 'I have had to slow down to read signs like these' for monolingual versus bilingual signs.

Tourist

The tourist responses are displayed in Table E-30. Similar proportions stated that they had to slow down to read both types of sign and that they had to slow down only to read the bilingual sign.

Table E-30: Count of paired responses by the tourist group to the statement 'I have had to slow down to read signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	76	4
	No	75	8

There is a significant difference ($p<0.01$) between the answers given by tourists to the statement 'I have had to slow down to read signs like these' for monolingual versus bilingual signs.

E.6.1.2 Statement B: I find it difficult to find the information I am looking for on signs like these

Non-Gaelic

Table E-31 displays the count of the Non-Gaelic group's paired responses to the statement 'I find it difficult to find the information I am looking for on signs like these' for the monolingual and bilingual sign. No one in this group stated that they found it difficult to find information on the monolingual sign but not on the bilingual; however a large majority (nearly half of Non-Gaelic participants) stated that they found it difficult to find information on bilingual signs and not on monolingual signs.

Table E-31: Count of paired responses by the Non-Gaelic group to the statement 'I find it difficult to find the information I am looking for on signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	57	0
	No	83	36

There is a significant difference ($p<0.01$) between the answers given by Non-Gaelic readers to the statement 'I find it difficult to find the information I am looking for on signs like these' for monolingual versus bilingual signs.

Gaelic

As shown in Table E-32 the majority of the Gaelic group found it easy to find information on either type of sign.

Table E-32: Count of paired responses by the Gaelic group to the statement 'I find it difficult to find the information I am looking for on signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	29	1
	No	17	54

There is a significant difference ($p<0.01$) between the answers given by Gaelic readers to the statement 'I find it difficult to find the information I am looking for on signs like these' for monolingual versus bilingual signs.

Tourist

Table E-33 displays the count of responses to 'I find it difficult to find the information I am looking for on signs like these'. The majority of the tourists did not find it difficult to find information on the monolingual sign but found it challenging to find the correct information on the bilingual.

Table E-33: Count of paired responses by the tourist group to the statement 'I find it difficult to find the information I am looking for on signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	52	1
	No	80	29

There is a significant difference ($p<0.01$) between the answers given by tourists to the statement 'I find it difficult to find the information I am looking for on signs like these' for monolingual versus bilingual signs.

E.6.1.3 Statement C: I have been distracted when driving because of signs like these

Non-Gaelic

The number of each response by the Non-Gaelic group to the statement 'I have been distracted when driving because of signs like these' is shown in Table E-34. Only two people in this group stated that the monolingual sign had distracted them but the bilingual had not. A large number of participants stated that they had not been distracted by monolingual signs but had been by bilingual signs.

Table E-34: Count of paired responses by the Non-Gaelic group to the statement 'I have been distracted when driving because of signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	43	2
	No	70	61

There is a significant difference ($p<0.01$) between the answers given by Non-Gaelic readers to the statement 'I have been distracted when driving because of signs like these' for monolingual versus bilingual signs.

Gaelic

The Gaelic group's answers are shown in Table E-35. Most of the answers were 'no' for both the monolingual and bilingual sign.

Table E-35: Count of paired responses by the Gaelic group to the statement 'I have been distracted when driving because of signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	32	6
	No	15	47

There is not a significant difference ($p>0.05$) between the answers given by Gaelic readers to the statement 'I have been distracted when driving because of signs like these' for monolingual versus bilingual signs.

Tourist

The majority of tourists have been distracted only by the bilingual sign (see Table E-36).

Table E-36: Count of paired responses by the Tourist group to the statement 'I have been distracted when driving because of signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	40	4
	No	71	47

There is a significant difference ($p<0.01$) between the answers given by tourists to the statement 'I have been distracted when driving because of signs like these' for monolingual versus bilingual signs.

E.6.1.4 Statement D: I have taken a wrong turn because of signs like these

Non-Gaelic

The counts of each response to 'I have taken a wrong turn because of signs like these' for the Non-Gaelic group are shown in Table E-37. Most of the Non-Gaelic readers have not taken a wrong turn because of monolingual or bilingual signs.

Table E-37: Count of paired responses by the Non-Gaelic group to the statement 'I have taken a wrong turn because of signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	26	3
	No	31	116

There is a significant difference ($p<0.01$) between the answers given by Non-Gaelic readers to the statement 'I have taken a wrong turn because of signs like these' for monolingual versus bilingual signs.

Gaelic

The Gaelic group's responses are shown in Table E-38. A similar number of this group have taken a wrong turn due to the monolingual sign but not the bilingual than those who have reported the opposite; wrong turn because of bilingual sign but not the monolingual.

Table E-38: Count of paired responses by the Gaelic group to the statement 'I have taken a wrong turn because of signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	15	7
	No	9	70

There is not a significant difference ($p>0.1$) between the answers given by Gaelic readers to the statement 'I have taken a wrong turn because of signs like these' for monolingual versus bilingual signs.

Tourist

The majority of tourists have not taken a wrong turn due to either type of sign. However, of those who have taken a wrong turn, more people took a wrong turn because of the bilingual sign than the monolingual.

Table E-39: Count of paired responses by the Tourist group to the statement 'I have taken a wrong turn because of signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	24	1
	No	30	107

There is a significant difference ($p<0.01$) between the answers given by tourists to the statement 'I have taken a wrong turn because of signs like these' for monolingual versus bilingual signs.

E.6.1.5 Statement E: I have had to stop the car to read signs like these

Non-Gaelic

The responses given for monolingual and bilingual signs by the Non-Gaelic group to 'I have had to stop the car to read signs like these' is shown in Table E-40. No one in this group reported having to stop the car to read monolingual signs but not bilingual. On the other hand, 18 people reported having to stop the car for a bilingual sign but not the monolingual alternative.

Table E-40: Count of paired responses by the Non-Gaelic group to the statement 'I have had to stop the car to read signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	9	0
	No	18	149

There is a significant difference ($p<0.01$) between the answers given by Non-Gaelic readers to the statement 'I have had to stop the car to read signs like these' for monolingual versus bilingual signs.

Gaelic

Most of the Gaelic group reported never having to stop the car to read either monolingual or bilingual signs (see Table E-41).

Table E-41: Count of paired responses by the Gaelic group to the statement 'I have had to stop the car to read signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	6	1
	No	8	86

There is a significant difference ($p<0.05$) between the answers given by Gaelic readers to the statement 'I have had to stop the car to read signs like these' for monolingual versus bilingual signs.

Tourist

Table E-42 displays the number of paired responses by the tourist group. 15 time as many people reported stopping the car to read bilingual signs than monolingual.

Table E-42: Count of paired responses by the tourist group to the statement 'I have had to stop the car to read signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	13	2
	No	30	117

There is a significant difference ($p<0.01$) between the answers given by tourists to the statement 'I have had to stop the car to read signs like these' for monolingual versus bilingual signs.

E.6.1.6 Statement F: I have been involved in an accident because of signs like these

Since no one reported being in an accident as a result of the monolingual sign the counts were too small to carry out any statistical test. Two people (one Non-Gaelic and one tourist) reported being in an accident as a result of a bilingual sign.

E.6.1.7 Statement G: I had a 'near miss' because of signs like these

Non-Gaelic

Table E-43 displays the count of the Non-Gaelic group's paired responses to the statement 'I have had a near miss because of signs like these' for the monolingual and bilingual sign. Very few people stated they had an accident due to either sign. Of those who did report a 'near miss' there was 4 times more accidents as a result of bilingual signs than there were due to monolingual.

Table E-43: Count of paired responses by the Non-Gaelic group to the statement 'I have had a near miss because of signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	2	2
	No	8	164

There is not a significant difference ($p>0.1$) between the answers given by Non-Gaelic readers to the statement 'I had a near miss because of signs like these' for monolingual versus bilingual signs.

Gaelic

Table E-44 shows the Gaelic group's responses. Only 8 people reported having a 'near miss' due to either or both types of sign.

Table E-44: Count of paired responses by the Gaelic group to the statement 'I have had a near miss because of signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	3	1
	No	4	94

There is not a significant difference ($p>0.1$) between the answers given by Non-Gaelic readers to the statement 'I had a near miss because of signs like these' for monolingual versus bilingual signs.

Tourist

The tourist answers to this question are displayed in Table E-45. 9 people had a 'near miss' because of bilingual signs but not monolingual whilst only 1 reported that the opposite was the case; a 'near miss' occurred because of a monolingual sign but not because of a bilingual.

Table E-45: Count of paired responses by the tourist group to the statement 'I have had a near miss because of signs like these' for monolingual and bilingual signs

		Bilingual Sign	
		Yes	No
Monolingual sign	Yes	2	1
	No	9	147

There is a significant difference ($p<0.05$) between the answers given by tourists to the statement 'I had a near miss because of signs like these' for monolingual versus bilingual signs.

E.6.2 Additional general statements regarding bilingual signs

E.6.2.1 Statement H: The presence of Gaelic makes it difficult for me to read the English on signs like these

Table E-46 shows the proportion of Gaelic, Non-Gaelic and tourist participants which respond 'yes' or 'no' to the statement 'the presence of Gaelic makes it difficult for me to read the English on signs like these'. The proportion of the Non-Gaelic and Tourist group which states that the Gaelic does make it difficult to read the English on the signs is similar to the proportion of the Gaelic who disagree with this statement.

Table E-46: Proportion of each group which responds 'yes' or 'no' to the statement 'the presence of Gaelic makes it difficult for me to read the English on signs like these'

Presence of Gaelic makes it difficult to read English?	Non-Gaelic	Gaelic	Tourist
Yes	75%	20%	76%
No	25%	80%	24%

E.6.2.2 Statement I: The presence of English makes it difficult for me to read the Gaelic on signs like these

The proportion of each response to the statement 'the presence of English makes it difficult for me to read the Gaelic on signs like these' is recorded for the Gaelic, Non-Gaelic and tourist groups in Table E-47. All of the Non-Gaelic group, and all but 1 person in the tourist group, responded 'no' to this statement. These responses are probably due to the fact these people can't read Gaelic. Only a very small proportion (9%) of the Gaelic group reported that the English made reading the Gaelic difficult.

Table E-47: Proportion of each group which responds 'yes' or 'no' to the statement 'the presence of English makes it difficult for me to read the Gaelic on signs like these'

Presence of English makes it difficult to read Gaelic?	Non-Gaelic	Gaelic	Tourist
Yes	0%	9%	1%
No	100%	91%	99%

E.6.2.3 Question: Do you read the English or the Gaelic directions, or both, when driving?

Table E-48 shows the proportion of Gaelic, Non-Gaelic and tourist participants who respond 'English', 'Gaelic' or 'Both' when asked which language they read on road signs when driving. For both the Non-Gaelic and tourist groups nearly everyone said that they only read the English part of the sign; a very small minority said they read both. In the Gaelic group however, the majority responded that they read both, 32% said they read the English only and 7% said they only read the Gaelic.

Table E-48: Proportion of each group which read English, Gaelic or both when driving

Read English or Gaelic on signs when driving?	Non-Gaelic	Gaelic	Tourist
English	99%	32%	99%
Gaelic	0%	7%	0%
Both	1%	61%	1%

Appendix F Summary of local authority interviews

Aberdeenshire

This is one of the larger local authorities in Scotland by land area and by population. The roads consist mainly of busy single carriageways and single track roads. There are few dual carriageways and no budget for major road schemes.

There is no history of Gaelic in this area, which it was noted was "completely alien" in this area. The indigenous language/dialect is Doric. Three of the interviewees are native to north east Scotland and fluent in the local linguistic tradition of Doric.

Although the Scottish Government is promoting Gaelic, one interviewee's personal view is that this should occur in schools, not through the use of bilingual road signs. Doric is promoted in schools in this area.

No complaints have been received about a lack of bilingual signs in the area. However the representatives of the local authority thought it possible that there would be complaints if any were erected. There are speakers of other languages in this region (for example Polish) that might make demands for bilingual signs in their languages.

The tourist industry is important in this area. It was felt that road signs are mainly used by tourists, as the local residents know where they are going. Bilingual signs might give a feeling of being in Scotland for the tourists, but no-one who needs to read the sign would be able to read it.

It was the feeling of the local authority representatives that the legal purpose of signs is to convey information, and with as much clarity as possible. They should be functional and not used for propaganda purposes. There is a limited amount of information that can be shown on a sign. More information will need more or bigger signs which will have a cost implication on:

- materials;
- possible site purchase;
- and requirement for passive safety features.

It was noted that the provision of gritting lorries was of greatest concern to residents in terms of transport budgets.

There were also aesthetic considerations related to an increase in sign clutter, which goes against another Scottish Government policy on signs in the countryside.

Argyll and Bute

The area is predominantly rural with a number of small towns, and very sparsely populated hinterland. The local authority contains 10% of the total area of Scotland but 2% of the population. There is a slightly higher proportion of private cars because geographic area doesn't lend itself to public transport links.

In the north of the region there are still many Gaelic signs, and Gaelic speakers are more common. The local authority has a Gaelic Language Plan and a range of Gaelic services available. One of the supporting arguments for using Gaelic has been the benefit to the tourist industry. Street nameplates are generally bilingual, and there are bilingual town/village signs. Local road signs in the towns are not bilingual, but there is an expectation that as signs are replaced they will be bilingual ones.
There were initially a number of complaints about the bilingual programme on the trunk roads, mainly regarding cost (that the money should be spent, for example, on repair of road surfaces), and that it is prejudicial to road safety, based on small amounts of

anecdotal evidence. The cost concerns were based on lack of understanding that the local authority was not paying for signs.

The interviewee had concerns about the number of lines of text on a bilingual sign, which might mean drivers take longer to assimilate the information. It was suggested that if the English and Gaelic names are identical or similar then just the Gaelic version should appear on the sign.

If all route confirmatory signs were replaced to be consistent there would be a large cost burden. There is an expectation of continuity with signs, but if they are replaced only when damaged or old, the interviewee had concerns that there could be a mis-match of types of signs along the route. In addition, bilingual signs need stronger poles because they are bigger signs.

Fife

The local authority area includes a small number of large towns, a large port, and a substantial length of rural roads. There are three major trunk roads, and a reasonable flow of heavy goods vehicle traffic on these and other distributor roads.

The area receives some tourist traffic. However, most of the crash and casualty statistics relate to local drivers, and there is no evidence, anecdotally or otherwise, that would suggest there is a traffic management or road safety problem that would indicate road users require bilingual signs.

The interviewees were not aware of any discussions within the local authority regarding the requirement for Gaelic bilingual signs in relation to transportation. There have been some discussions relating to bilingual signs with overseas languages located near to the port. These would be intended as an initial guide to overseas drivers to direct them onto the main distributor routes.

There has been a noticeable influx of Polish speakers to the area, and one interviewee suggested as a personal view that it may be more relevant in this local authority area to have bilingual signs in languages other than Gaelic, if indeed there was a case to support such action. There are no supplementary Gaelic signs for town names. The personal view of one of the interviewees was that there was not a large cultural Gaelic requirement in the authority area and that the cultural issue of Gaelic was not relevant to the local population.

Correspondence from local residents indicates that there can be some concerns around the proportion of budgets spent on core road maintenance versus other transportation service delivery areas and one interviewee said that if Gaelic bilingual signs were planned, even if funding was provided by Transport Scotland, "the postbag would be full" and the perception within the community would be that the local authority was prioritising its core budgets on this rather than other roads and transportation needs.

Current local authority policy is for road signs to be replaced only when damaged through road accidents, vandalism or wear and tear. It was suggested that if bilingual signs were to replace current signage, the funding would need to come from outside the authority. An increase in the size of sign would be required to accommodate the increase in the number of lines of text, and the larger signs would require stronger support structures. Depending on the size of the sign, consideration would also have to be given to passive road safety measures such as barriers or collapsible poles. To support consistency in signage, the interviewees questioned whether signs painted on the road, or variable message signs would also need to be bilingual.

It was suggested that a way forward may be for local authorities that are out-with the traditional Gaelic areas to have signs with Gaelic "gateway messaging" or other strategic and focussed applications rather than blanket application. Once closer to the Gaelic-speaking areas there would be a greater need to give a "strong message about where

you are and who we are as a people". It was felt that a graded approach would be more deliverable than a blanket approach.

Highland Council

The local authority is responsible for 4200 miles of local roads; in addition there are 590 miles of trunk road within the Highland Council area.

The local authority is very supportive of the Gaelic language. Originally the decision in determining the use of bilingual signs was devolved to individual areas, but there is now one policy for all areas within the Highland Council region. Some parts of the local authority area have a very strong Gaelic tradition, but other areas, while supportive of Gaelic, are resistant to the use of bilingual signs. The local authority has a clear policy that the bilingual sign is used where there is an authentic Gaelic translation for a place name. The interviewee reported that the policy of introducing bilingual signs was not about Gaelic speakers finding their way around, it was about raising the profile of the language.

In support of the Gaelic language plan, the local authority is replacing road signs with bilingual signs as they become damaged or worn. It was noted that on average bilingual signs cost approximately 30% more than the original signs. Some of the larger signs require bigger posts and foundations and this can increase the cost considerably. Although it had not yet been required, the interviewee pointed out that it could be necessary to install passive safety measures where larger signs were needed.

In some cases, two bilingual signs replace one monolingual sign where there is already a long list of place names displayed on the sign. The interviewee expressed concerns about additional signs seemingly contradicting government policies which promote a reduction in sign clutter. Correspondence has been received from the public regarding concerns about the road safety aspect of bilingual signs, but they were all based on anecdotal events, and mainly concerning the length of time taken to read the signs.

The interviewee suggested that it would be useful to observe driver behaviour at the bilingual road signs to see whether there is evidence that drivers slow down to read the signs.

Perth and Kinross

While the local authority promotes the Gaelic language in schools, there is no current pressure to introduce bilingual road signs. The last time it was put to the local authority the view was that the cost meant it was not a priority. The interviewee suggested, however, that there may be pressure in the future from those interested in promoting the language. There is a greater Gaelic influence in the north of the region and there may be a perception that Gaelic road signs would be attractive for tourists.

Historically, bilingual signs were considered ten years ago with respect to town and village naming. It was found that some towns did not have a natural Gaelic translation, and creating one was felt to be meaningless. When wider local authority members were consulted, the scheme was rejected due to cost. Some bilingual signs were introduced in a localised area for a festival, but these did not extend to route signs. There could be a perception that bilingual signs would add something to the "Highland Perthshire" experience, but that this would be diluted if the signs were introduced right across Scotland.

The road infrastructure budget is tight, and road maintenance would receive priority for spending. In the current financial situation, the prospect of assigning funding to replacing road signs with bilingual signs might not be favoured if this competed with demands for other services, such as in social care.

It was estimated that the cost of implementation for replacing road signs with bilingual signs would run into seven figures, and it was thought to be inconceivable that the local authorities would be able to fund this without help from central Government.

Bilingual signs could be introduced on a piecemeal basis when the current signs need replacing as part of a maintenance programme. However, it was noted that as signs typically last for as long as 20 years, inconsistencies in signage along a route would result. There are also concerns about the ongoing maintenance of the bigger signs.

There is pressure from some sources, such as those interested in the look of the countryside or environment, to reduce the size of signs, or remove them altogether, for aesthetic reasons.

The interviewee had a road safety background, and expressed concerns about putting information on road signs that was not strictly necessary. However, it was noted that the use of bilingual signs in Wales had not resulted in an increase in collisions.

Stirling

Around 60% of the road network in this local authority's area is rural roads. There are several trunk roads, which are also the top accident spots.

In the summer of 2009 a consultation was carried out with the community local authorities in this area concerning all bilingual signage. Road signs are seen as the most tangible introduction of Gaelic bilingual signs.

The primary concerns raised by the consultation was whether bilingual signs would distract drivers, whether maintenance of a larger sign would have cost implications and whether there would be a tourist benefit. From a 70% return a substantial amount (87%) rejected the motion. The main reasons for rejection concerned cost. Replies included statements such as "in view of current economic crisis..." "cost and safety" "nice to have but money could be better spent" "issue not significant in this area" "cost disproportionate to potential benefits".

Many local authorities had limited budgets and were prioritising maintenance issues such as repair of potholes and winter maintenance of roads. The local authorities were going to consider the replies in the next stage of the consultation process.

The interviewee questioned the benefit of bilingual road signs. If the main reason is to portray uniqueness of the area for tourism purposes, widespread bilingual signs may dilute this uniqueness. It was felt that school, library or other public building signs may be a more appropriate way to raise awareness and interest in the Gaelic language.

Analyses of the effects of bilingual signs on road safety in Scotland – final report

Bilingual signs were installed on selected trunk roads in Scotland following a feasibility study in 2002. Since the introduction of the signs, there has been no evaluation of what impact the signs may have had on driver behaviour, attitudes or accident rates. Transport Scotland commissioned TRL to lead a project investigating whether there is evidence that bilingual signs have had any effect on road safety and to establish the public's attitudes towards the signs. The main report presents the results of the project, which used three sources of evidence to establish the likely effect of the signs on driver behaviour and attitudes in relation to road safety. Results of a review of international literature, analysis of accident data and a survey of 440 drivers are considered in the context of the Task Capability Interface model (Fuller, 2005) of driver behaviour. The report suggests that while there is reasonable evidence to infer bilingual signs increase the demand of the driving task, drivers appear able to absorb this extra demand, or negate it by slowing down, which ultimately results in no detectable change in accident rates.

Other titles from this subject area

INS005	How can we produce safer new drivers? S Helman, G B Grayson and A M Parkes. 2010
TRL673	Monitoring progress towards the 2010 casualty reduction target – 2008 data. J Broughton and J Knowles. 2010
PPR522	Cross-modal safety: risk and public perceptions – phase 2 report. D Lynam, J Kennedy, S Helman and T Taig. 2010
PPR513	Linking accidents in national statistics to in-depth accident data. D C Richards, R E Cookson and R W Cuerden. 2010
PPR498	Further analyses of driver licence records from DVLA. J Broughton and B Lawton. 2010
PPR446	The potential for cycle helmets to prevent injury – a review of the evidence. D Hynd, R Cuerden, S Reid and S Adams. 2009
PPR442	Passion, performance, practicality: motorcyclists' motivations and attitudes to safety – motorcycle safety research project. S Christmas, D Young, R Cookson and R Cuerden. 2009
PPR427	The accident history and behaviours of new drivers who pass their first practical driving test. B Sexton and G Grayson. 2010
PPR418	Mobile phone and seat belt usage rates in London 2009. S Narine, L K Walter and S C Charman. 2010
PPR414	The effect of traffic signal strategies on the safety of pedestrians. J Kennedy, M Crabtree, J Castle, J Martin and M Elliott. 2009

Price code: 5X

ISSN 0968-4093

ISBN 978-1-908855-15-2

PPR589

TRL
Crowthorne House, Nine Mile Ride
Wokingham, Berkshire RG40 3GA
United Kingdom
T: +44 (0) 1344 773131
F: +44 (0) 1344 770356
E: enquiries@trl.co.uk
W: www.trl.co.uk

Published by

IHS
Willoughby Road, Bracknell
Berkshire RG12 8FB
United Kingdom
T: +44 (0) 1344 328038
F: +44 (0) 1344 328005
E: trl@ihs.com
W: http://emeastore.ihs.com