# DOCTOR OF PHILOSOPHY

## How language, culture and emotions shape the mind

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# How language, culture and emotions shape the mind

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This thesis is submitted in partial fulfilment

for the degree of Doctor of Philosophy.

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Yn olaf, ond yn bwysicaf oll, hoffwn ddiolch i fy rhieni. Rydych chi'ch dau wedi bod yn ffynhonnell gyson o gariad, anogaeth ac ysbrydoliaeth dros y blynyddoedd, ac rydych bob amser wedi fy nghefnogi yn ddi-ffael. Diolch yn fawr iawn am bob dim.

# Contents

Summary vii

Chapter 1

Introduction and Literature Review 1

Chapter overview 2

Language and worldview: The seeds of linguistic relativity 2

The linguistic relativity hypothesis 4

Linguistic relativity at the level of perception and categorisation 6

Representations and concepts 11

Language and the self 14

Language and the collective 17

Emotion, culture and social cognition 20

Thesis aims: A meeting point for language, culture and emotion 22

Chapter summary 23

Chapter 2

Methodological Considerations 25

Chapter overview 26

Event-related brain potentials 26

The N400 28

The Implicit Association Test (IAT) 30

Mood manipulation 31

Participants 32

Chapter summary 34

Chapter 3

Language and culture modulate online semantic processing 37

Abstract 38

Introduction 39
Materials and Methods 41
Participants 41
Stimuli and procedure 42
Electrophysiological recording 44
Results 44
Behavioural data 45
Electrophysiological data 46
Discussion 48

Chapter 4
Languages flex cultural thinking 53
Abstract 54
Introduction 55
Materials and Methods 56
Participants 56
Stimuli 57
Norming of stimuli 58
Procedure 59
Behavioural data analysis 60
ERP analysis 61
Results 61
Behavioural results 61
Electrophysiological results 64
Discussion 65

Chapter 5
Native language, or first language? Defining the effect of language on cultural semantics 71
Abstract 72
Introduction 73
Method 77

Participants 77
Stimuli and procedure 78
Results 79
Discussion 83

Chapter 6
Mood and language interact to affect implicit cultural biases 87
Abstract 88
Introduction 89
Method 93
Participants 93
Stimuli 94
Procedure 99
Data analysis 100
Results 101
Discussion 103

Chapter 7
Discussion 109
Chapter overview 110
Language and culture interact to modulate online semantic processing 111
The language-culture link is modulated by the processing of emotions 114
Language and transient emotions interact to modulate implicit cultural biases 119
Directions for future studies 123
Final remarks 124

References 127

Appendix A
Language and culture modulate online semantic processing 165

Appendix B

Experimental sentences used in Chapter 3 171

Appendix C

Experimental sentences used in Chapter 4 187

## Summary

The influence of language on thought has been a fervent topic of philosophical and empirical debate for over half a century (see Wolff & Holmes, 2010, for a review). Recent advances in neuroscientific methods have enabled researchers to show that language influences perception and thought from the earliest stages of stimulus processing, even when the task is apparently dissociated from linguistic processes (c.f. Thierry, Athanasopoulos, Wiggett, Dering, & Kuipers, 2009; Boutonnet, Athanasopoulos, & Thierry, 2012; Boutonnet, McClain, & Thierry, 2014; Athanasopoulos et al., 2015). The purpose of the current thesis is to extend this investigation to specifically focus on the impact of culture-specific conceptual representations and linguistic context on semantic processing and affective biases. To this end, the thesis comprises four empirical studies in which we assess how each language possessed by bilinguals relates to their semantic cultural knowledge.

Thus, this thesis seeks to establish (i) **whether** a particular link exists between native language and semantic knowledge concerning the native culture (Chapter 3); and (ii) **the nature** of this link, with a specific emphasis on long-term, immutable emotional associations (Chapter 4) and short-term, ephemeral emotional states (Chapter 6). I also examine the specificity of the language-culture link as a property of language status in the bilingual mind (Chapter 5).

To summarize the findings in advance, I show that bilinguals' languages diverge when processing information that is specifically related to the native culture. The findings also indicate – via our emotional manipulation – a fundamental

difference in processing style between the two languages. Whereas the second language (L2) is characterized by a more rational processing style, the first language (L1) has a greater tendency to bias. Moreover, the particular language-culture link only appears to exist when the native language is not only strongly associated with the native culture, but when it is also the bilingual's dominant language.

Overall, the work presented in this thesis provides novel evidence for the effect of language, culture, and emotions on cognition, even at the level of semantic knowledge.

# Chapter 1

## Introduction and Literature Review

*"To speak another language is to possess a second soul"*

- Charlemagne

## 1.0 Chapter overview

In this chapter, I will review the evidence concerning the influence of language on cognition. I begin by outlining the evidence pertaining to the influence of language on basic human cognitive operations such as perception and categorisation. I then discuss these effects at higher levels of representation and conceptualisation, specifically focusing on the role of language in mediating knowledge and attitudes to aspects of personhood, using the case of cultural identity. I then move on to discuss the substantive literature that show the effects of emotions on social attitudes and bias, and I consider the possible interaction between language and emotion in influencing cognition. I end the chapter by formulating the thesis aims.

## 1.1 Language and worldview: The seeds of linguistic relativity

Language is a distinctive communicative device possessed by humans, which arguably distinguishes us from other species (see Bickerton, 1995, for a review). Language has evolved from expressions of simple sounds to being a rich, complex system with distinct rules and features, allowing direct communication of thought from one human being to another. The origin of language is a long-debated topic: Kant (as cited in Forster, 2012) postulated the idea that language arose from the need to express logical, rational thought, whilst contemporaries such as Rousseau rather viewed

language as an expression of emotions (as cited in Bertram, 2004). Indeed, two notable German philosophers: Johann von Herder (1744 - 1803) and Wilhelm von Humboldt (1767 - 1835) proposed the idea that language has the power to alter an individual's worldview. For example, von Herder ([1772], 1960) stated that language is inextricably linked with a group of people, or nation, and that this gives rise to a unique way of thinking, reflected in their language use:

> "If it be true that we learn to think through words, then language is what defines and delineates the whole of human knowledge … In everyday life, it is clear that to think is almost nothing else but to speak. Every nation speaks according to the way it thinks and thinks according to the way it speaks." (translated in Kramsch, 2008, pp. 99-100)

Around the same time, von Humboldt's focus was rather on how language is a system that is unique to each individual, and that acquiring a new language, as an additive, interactive, and dynamic instrument of human thought, can allow individuals to expand their worldview:

> "The learning of another language should … mean the gaining of a new standpoint towards one's worldview, and it does this in fact to a considerable degree, because each language contains the entire conceptual web and mental imagery of a part of humanity." (translated by Cowan, in von Humboldt, 1963; pp. 294)

These fundamental ideas would later provide a foundation for theorists and empiricist interested in language-thought interactions, specifically, the influence of language on the categorisation and perception of our world.

## 1.2 The linguistic relativity hypothesis

The *linguistic relativity* hypothesis - also referred to as the Sapir-Whorf hypothesis, or Whorfianism - is the modern term for the hypothesis that language can affect thought (Whorf, 1956). The hypothesis posits that languages differ significantly in their constructs of meaning (Malt & Wolff, 2010; Evans & Levinson, 2009; Majid, Bowerman, Kita, Haun, & Levinson, 2004), and as such these constructs affect the way in which speakers perceive and conceptualise the world which allows speakers of different languages to hold different worldviews (Whorf, 1956; see Wolff & Holmes, 2010, for a review).

In his early career as a fire safety inspector an insurance company, Benjamin Lee Whorf was confounded by the observation that different people had different perceptions concerning the relationship between empty and full fuel cylinders and their probability of explosion. Empty cylinders were erroneously perceived as less dangerous, which Whorf concluded originated from use of the words 'empty' and 'full'; 'empty' being a word typically further removed – in terms of its conceptual features – from words such as 'explosion' and 'danger', compared with words such as 'full'. Such reflections and introspections latterly influenced his career as a linguist, as is clear from his famous quote that describes how "Language is not simply a reporting device for our experience, but a defining framework of it" (Whorf, 1956).

Despite its early popularity, the notion that language can influence thought fell out of favour during the 1950s and 60s (Hunt & Agnoli, 1991), due to the rise in nativism. Prominent opponents such as Chomsky (1965) and Pinker (1995), for

example, condemned the hypothesis, owing to its supposedly deterministic standpoint: That is, the notion that speakers of different languages think differently because language determines the basic categories of their thoughts. Nativists instead argue that all humans are "hard-wired" with the ability to acquire language. This view is encapsulated in the Universal Grammar hypothesis that describes how all languages share some fundamental similarities, and thus are attributable to a single human language that is a sophisticated and highly constrained structure distinct from all other aspects of human cognition (Chomsky, 1986; 1995).

However, such unilateral criticism and over-citation of Whorf's famous quote was perhaps unwarranted, given that it ignored certain subtleties of the arguments in Whorf's writings. In addition to delineating the deterministic viewpoint of language-thought operations – latterly considered to be the 'strong' hypothesis of linguistic relativity – Whorf also considered how different language structures are incorporated in the mind to influence thought, thus promoting a more interactive relationship between language and thought, rather than proposing that language *governs* thought:

> "Any activations [of the] processes and linkages [which constitute] the structure of a particular language … once incorporated into the brain [are] all linguistic patterning operations, and all entitled to be called thinking." (Whorf, 1937, as cited in Lee, 1996, pp. 57–58)"

The linguistic relativity hypothesis was revived during the 1990s with the advent of new theoretical reasoning and methodologies to approach the problem (e.g., Lucy, 1992; Levinson, 2003; Slobin, 1996). The deterministic account was largely discounted,

primarily due to evidence showing that high-level cognition is evident in young children and animals that do not possess sophisticated language skills (Gallistel, 1989; Feigenson, Dehaene, & Spelke, 2004; Hare, Call, & Tomasello, 2001; Phillips & Santos, 2007), and recent enquiry is concerned with investigating the influence of language on different levels of human cognition (Lucy, 1992).

## 1.3 Linguistic relativity at the level of perception and categorisation

In empirically validating the effect of language on cognition, one approach is to ascertain the effect of language on human perception and cognition, when the task has no obvious link with language. In logical terms, a demonstrable link provides evidence that a supposedly non-linguistic function is influenced by the specific parameters of the individual's language. For this reason, researchers have often focused on the relationship between colour perception – a supposedly intractable, cognitively low-level function – and the specific linguistic features of colour words. In particular, such studies show that two colours can be judged as being similar – even when they diverge in terms of their visual properties – if they share the same linguistic label (Roberson, Davidoff, Davies, & Shapiro, 2005; Winawer et al., 2007), and several behavioural cross-linguistic studies have moreover reported effects in which colour labels augment categorisation and memorisation (Harnad, 1987).

In a behavioural study investigating the effects of language on colour discrimination, Winawer et al. (2007) tested whether English and Russian speakers differed in performance on a speeded colour perception task. Interestingly, unlike

English, Russian doesn't have a single term for the colour blue; rather, there are separate terms for both light (*goluboy*) and dark (*siniy*) shades of blue. Participants were presented with blue squares arranged in a triad, and were asked to match two of the squares in terms of colour shade as quickly as possible. Russian speakers were found to be faster at discriminating the shades of blue if they had different colour labels, whereas English speakers showed no advantage in the same task. Furthermore, when the task was conducted in conjunction with a verbal interference task, these effects diminished. Such results provide compelling evidence that language even affects *online* perception of visual stimuli.

Gilbert, Regier, Kay and Ivry (2006) also investigated Whorfian effects on colour perception in a study using a visual search task, in which reaction times are deemed a dependable indicator of visual processing. Squares of the same shade of blue, or green, were arranged in a circle around a fixation cross. One of the squares - the deviant - was either a different shade of the same colour (within-category) or was shaded with the other colour (between-category). Participants were asked to indicate as quickly as possible - whilst looking at the fixation cross - if the deviant square appeared in the right or left half of the circle. Results showed that the between-category discrimination responses were much faster when squares appeared on the right as compared to the left. Therefore processing in the left hemisphere, mostly associated with language, was influenced by the linguistic label of the colour presented. Even though these results are compelling, the precise processing stages

involved are unclear, as the reaction time benefits could be deemed a consequence of strategic post-perceptual processing.

The advent of methodologies such as encephalography (EEG), and its widespread use in cognitive neuroscience has allowed examination of perceptual and cognitive processing at a precise temporal level (see Chapter 3 for further discussion of these methods). In a study measuring online event related brain potentials (ERPs), Thierry et al. (2009) presented groups of Greek and English speakers with colour patches of light and dark shades of green and blue in a colour oddball detection task. Greek speakers were found to have relatively greater disparity in the wave associated with visual mismatch negativity (vMMN) specifically in response to light and dark shades of blue; an effect that was absent in English speakers, and from responses to light and dark shades of green. Thierry et al. (2009) proposed that greater divergence in perception of blue shades in Greek speakers stemmed from separate colour labels to distinguish light blue (*ghalazio*) from dark blue (*ble*) in Greek; a distinction that is absent in English, and from both languages in relation to light and dark shades of green. These results establish that language affects colour perception, even at the earliest, unconscious stages of cognition.

Athanasopoulos (2009) further proposed that the distinction between light and dark blue in Greek and English could depend on the availability of these linguistic terms in semantic memory. In an extension of this work, Athanasopoulos et al. (Athanasopoulos, Damjanovic, Krajciova, & Sasaki, 2010a; Athanasopoulos, Dering, Wiggett, Kuipers, & Thierry, 2010b), suggested that more time spent in the country of

one's acquired language (second language; L2) resulted in categorical perception that was similar to the native speakers of that country: Brain potentials revealed that Greek-English bilinguals who had been immersed in the their L2 (by virtue of residing in the UK in which English is dominant) for more than 18 months demonstrated more similar processing to that of monolingual English controls as compared to Greek-English bilinguals who had only been living in the UK for less than three months. Further behavioural research explored these effects in speakers of Japanese, which also has different labels for light and dark shades of blue. Interestingly, the colour perception effects among bilingual individuals depended upon the speaker's dominant language, as English dominant speakers showed more difficulty in distinguishing between light and dark blue compared to those who used Japanese as their primary language (Athanasopoulos et al., 2010a). These studies provide convincing evidence that linguistic labels affect perception, and suggest a primary role for the dominant language in driving perception and categorisation behaviour.

Behavioural studies have also established overt effects of language on object identification and categorisation (e.g., Ameel, Storms, Malt, & Sloman, 2005; Pavlenko & Malt, 2010). Boutonnet, Dering, Viñas-Guasch, and Thierry, (2013) were the first to investigate such effects online, using a similar ERP method to that used in Thierry et al. (2009). Object categorisation was examined amongst two groups of English and Spanish speakers. Whereas English has separate linguistic labels for the objects cup and mug, in Spanish both objects are refered to as '*taza*'. Results of the visual oddball paradigm revealed that when English speakers habituated to one stimulus (e.g., cup)

they were more sensitive to the change to the related stimulus (e.g., mug) – revealed in larger deviant-related negativity (DRN) – compared to Spanish speakers. Taken together, these findings from ERPs reveal compelling evidence that language-specific lexical labels affect both online perception and the conceptual structures of objects.

Recent studies have also shown that these effects are not limited to lexical idiosyncrasies, with evidence showing that grammatical gender also affects object categorisation (e.g., Boutonnet et al., 2012; Boroditsky, Schmidt, & Phillips, 2003; Bassetti, 2007; Forbes, Poulin-Dubois, Rivero, & Sera, 2008). In an early study, Boroditsky and Schmidt (2000) taught a group of German- and Spanish-English bilinguals a series of object-person name pairs in English (e.g., apple - Patrick). Participants were found to be more accurate at recalling the object name when its gender was congruent to that of the personal pronoun of their first language (L1). In another study with speakers of Spanish and German, Borodisky et al. (2003) asked participants to produce three adjectives in response to a picture; which were then rated on a scale to measure their masculine or feminine value. Spanish and German speakers showed the reverse description of nouns using feminine and masculine adjectives, reflecting their reverse assignation of grammatical gender in either language. For example, in response to a picture of a bridge, Spanish speakers produced adjectives that were rated as more masculine (*big, sturdy, towering*), compared with German speakers, whose adjectives were deemed more feminine (*beautiful, elegant, fragile*). Conversely, in response to a picture of a key, Spanish adjectives were rated as feminine (*intricate, lovely, tiny*), and German adjectives were rated as masculine

(*rough, hard, jagged*). Thus, adjectives were overall congruent with the object's grammatical gender in either language, suggesting that the grammatical features of language potentially influence the 'non-linguistic' domains of object perception, categorisation and conceptualisation (Boroditsky, 2001; Cubelli, Lotto, Paolieri, Girelli, & Job, 2005; Cubelli, Paolieri, Lotto, & Job, 2011).

## 1.4 Representations and concepts

Whilst recent years have seen a swell in the number of studies showing an influence of language on perception and low-level cognition, fewer studies have attempted to demonstrate linguistic effects at the representation level, defined by mental constructs that hold meaning about the world (that is, the depiction of the physical properties of the categorical world; for example, reading the word 'dog' evokes a series of mental processes that involve recalling its semantic category (animal), imagery of its physical form, such as its size and colouring, and any prominent episodic associations). Existing studies show that language terminology affects cognition in the domains of these lexically-driven semantic associations (Boutonnet et al., 2014) and motion conceptualisation (Kersten et al., 2010; Athanasopoulos et al., 2015).

Boutonnet et al. (2014) investigated the effects of words idiosyncratic to language and their impact on modulation of brain potentials pertaining to semantic association. For example, arbitrary concepts such as '*horse'* and '*sea*' were paired in order to construct the compound '*seahorse'*, and presented to participants in picture form. Concepts presented in compound order resulted in N400 amplitude - a measure

of semantic expectancy (see Chapter 3 for more detail) - comparable to that of unrelated control pairings, however, the reverse pairing of concept compounds (*horse-sea*) resulted in significantly reduced N400 amplitudes. These results suggest that within the lexicon, relations imposed by language have consequences for the organisation of semantic memory.

In a study that investigated the mental imagery of motion events, Slobin (2006) asked English and Spanish speakers to summarise a passage from a novel. English speakers tended to give rich information about the manner of motion employed by the character in the story; however, Spanish participants reported little or no information pertaining to the imagery of the manner of motion, even though physical details about the scene were recalled. When Spanish-English bilinguals completed the same task, their recall-style changed depending on the language in which they read and recalled the passages. Slobin (2006) found that the bilingual individuals gave accounts in a language-dependent fashion: when operating in English reports contained motion imagery, whereas Spanish reports were more focused on the physical aspects of the scene. Thus, the language of operation, i.e., the lexicon and grammar of the language, influenced the bilinguals' account of the material. These findings provide evidence for Slobin's (1996) thinking for speaking effect - viewed by some as a contemporary version of the linguistic relativity hypothesis - that proposes that language should have an affect on the *encoding* of thoughts into words. Which could be an explanation for the results reported above, for example, as the speakers were 'honed in' to distinctions made in the language of operation. Moreover, language can also interfere *during* the

production of utterances of thought, such that linguistic and non-linguistic representations either compete against, or facilitate, each other. Lastly, language can be affected *after* thought to prime non-linguistic processes, such as to highlight certain properties of objects. However, some have criticised these notions for limiting interpretations of linguistic relativity effects, as it posits that language is restricted to formulations before, during and after the production of utterances and does not provide enough grounding to extend the debate to non-linguistic thought (Pinker, 2007).

Athanasopoulos et al. (2015) found evidence for the influence of language on cognitive processes involved in motion categorisation. Across two studies, they investigated whether German-English bilingual participants responses differed depending upon the language of operation. Participants were shown three video clips that showed different types of motion in relation to a goal. The experimental target clip showed movement toward a goal location, with the other two clips showing arrival at a goal or movement toward an ambiguous goal in the distance. Monolingual German controls categorised clips with an ambiguous goal as similar to the target clip more often than English monolingual controls. For German-English bilinguals, when one of their languages was either not attended to, or interfered with by means of repeating strings of numbers, their responses shifted to be similar to the monolingual controls. That is, when German was blocked or not attended to, categorisation of the motion event patterned similarly to that of the English controls, and when English was blocked or not attended to, categorisation was similar to that of the German controls.

Thus, by showing that motion categorisation preferences could be fundamentally shifted by changing the language context, these findings suggest that language effects are context-bound, even within the same individual, depending upon the language of operation.

## 1.5 Language and the self

The research described up until this point shows that language-specific features – including the lexicon and grammar – affect low-level perception through to cognition at the level of representations and conceptualisations. There is also some existing evidence to suggest that the sphere of influence also extends to aspects of personhood, that is, an individual's concept of 'self', expressed in personal pronouns that encode complex relationships between the self and the world (e.g., I, us, you, them; see Pavlenko, 2005, for a discussion). Koven (1998, 2001) proposed that bilingual individuals, for example, possess an array of registers and codes that can be applied to present the self differently in different language contexts. Others have postulated that the self is central in narratives (Dennett, 1991), with anthropologists such as Ewing (1990) going further by suggesting that the self is not unitary, but instead is categorical, and that each notion of the self is different based upon different experiences and memories (see Schrauf & Rubin, 2003, for a discussion).

One way to empirically test the possible influence of language on notions of self is to examine this construct in the case of bilinguals. If bilinguals' representations of self is differentially influenced by the languages they speak, then measurable aspects of

'self' should differ in either language. Research into the effects of language on autobiographical memory has found that bilinguals tend to retrieve memories in the same language as the one in which they were encoded, and are moreover better able to remember in more detail and more vividly if the language of reporting is congruent with that of encoding (Schrauf, 2000; Schrauf & Rubin, 2003; Marian & Neisser, 2000). These effects encompass information concerning semantic knowledge, culture, and language (Rubin, 2006; Schrauf, Pavlenko, & Dewaele, 2003). Javier, Barroso, and Munoz (1993), for example, showed that stories recalled in the same language in which they were encoded are more elaborate and detailed and show a higher level of imagery. Moreover, the emotional content and emotional texture of the information recalled was also influenced by the congruency of the language of encoding. Autobiographical memory retrieval (in response to a positive or negative cue word; Marian & Neisser, 2000) in bilinguals has been investigated in Russian-English bilingual immigrants whose L2 (English) was acquired after their migration. The results show that during periods of their lives living in Russia, memories were more vividly remembered and expressed in Russian, and that even in their later acquired L2 the same pattern emerged (English recall was more vivid for memories encoded in English; Marian & Neisser, 2000).

Neural structures associated with memory retrieval and cognition (hippocampus, orbito-frontal cortex) have also been linked to areas implicated in emotions processing (amygdala; Greenberg et al., 2005). Therefore it is perhaps unsurprising that the emotional state of the observer appears to modulate the

relationship between language and autobiographical memory. The work of Barrett, Linquist, and Gendron (2007; Barrett; 2011), lends the view that emotional experiences are constructed based upon interactions between past experiences such as linguistic environment and respective neural structures involved in memory formation. Moreover, McClelland and Rogers (2003) propose that semantic knowledge is established through linguistic experience and the consolidation of neural pathways involved in semantic processing.

Previous research has also established a link between language and emotions processing. In bilinguals, the dominant language (L1) has stronger links and access to emotions (Altarriba, 2008; Pavlenko, 2008) compared with L2. In two studies, Dewaele investigated the perception of linguistic phenomena linked to emotions in speakers of different languages; the emotional potency of swear- and taboo- words (2004), and phrases such as 'I love you' (2008). The emotional strength of swear- and taboo- words was perceived more strongly in bilinguals' L1 compared with the L2, moreover, language proficiency and age of acquisition of L2 were found to predict the potency of these words. In the same vein, the effect of the phrase 'I love you' was found to be strongest in the L1, which was also further modulated by the factors language dominance, age of acquisition, and proficiency. Taken together, these findings tentatively suggest that the first language is the language of emotional dominance exhibited by stronger emotional reactions, whereas the second language is more emotionally detached, exhibited in weaker ratings of emotional significance.

More recent studies employing online methodologies have provided further evidence of differential emotional experience in the L1 and L2 (Altarriba & Basnight-Brown, 2011; Ponari et al., 2015; Opitz & Degner, 2012; Wu & Thierry, 2012). For instance, in a study measuring event related brain potentials, Chinese-English bilinguals' unconscious access to L1 translation equivalents when reading in their second language (Wu & Thierry, 2010), was repressed when words were of a negative valence (Wu & Thierry, 2012). These findings suggest that lexico-semantic access to the L1 is obstructed by negatively valenced information presented in the L2, which is not the case when the information is positive or neutral. These repression effects at the level of single word presentation have also recently been shown in the early course of semantic integration during sentence reading (Jonczyk, Boutonnet, Musial, Hoemann, & Thierry, 2016). In contrast, Opitz and Degner (2012) showed stronger brain potential modulations for emotional compared to neutral stimuli in both languages of the bilingual. However, there was a difference in the early onset of stimuli, with L2 onset occurring later, an effect that could be indicative of less automaticity in the processing of emotional words in the L2.

## 1.6 Language and the collective

Another facet of the 'personhood' construct is an individual's perception of themselves with reference to others, which in large part includes cultural identity (Pavlenko, 2005). Definitions of the term 'culture' vary (Kroeber & Kluckhohn, 1952;

Apte, 1994), but one such definition by Spencer-Oatey (2000) provides a valuable reference point:

> 'Culture is a fuzzy set of basic assumptions and values, orientations to life, beliefs, policies, procedures and behavioural conventions that are shared by a group of people, and that influence (but do not determine) each member's behaviour and his/her interpretations of the 'meaning' of other people's behaviour.' (pp. 4)

According to Schein (1990), culture can be split into three levels of conceptualisation: i) observable artefacts, including the material aspects of a culture, that is, the superficial manifestations of a culture and it's outward image; ii) espoused values, describing the underlying assumptions that determine how individuals within a culture perceive, think, feel and behave; and iii) basic assumptions, which are the unconscious beliefs and perceptions that are linked to thoughts and feelings.

Membership of a given culture can change an individuals' perception of others, causing a natural allocation of others into an in-group and an out-group (cf. Hogg & Abrams, 1988; Brewer, 1979). The in-group is congruent with one's cultural identity, and thus members of this group seem more pleasant, competent and independent (Tajfel, 1982; Mullen, Brown & Smith, 1992; Turner & Reynolds, 2001) as compared to members of the out-group, who are perceived to be inferior and homogenous (Quattrone & Jones, 1986). The social identity theory posits that individuals maintain their cultural identity based upon alignment with these favourable in-group features (Tajfel & Truner, 1986; Hodd & Abrams, 1988), as well as accentuating dissimilarities with the out-group (Brewer, 1979). However, other salient features that have been

shown to influence in-group out-group distinctions include regional dialect (Bourhis & Giles, 1976), shared belief-systems (Hendry, Mayer, & Kloep, 2007) and cultural practices (Day, Drakakis-Smith, & Davis, 2008).

Research has shown that a native language context strengthens one's biases towards the in-group, and against the out-group of that culture (Danziger & Ward, 2010; Ogunnaike, Dunham, & Banaji, 2010). Ogunnaike et al. (2010) used the implicit association test (IAT; also see Chapter 3) to measure implicit social group biases. The IAT is a widely used measure of implicit attitudes, which are measured based on the premise that it is easier to categorise related concepts than it is to categorise relatively unrelated concepts, therefore faster and more accurate responses to related concepts signal an automatic bias. Ogunnaike et al. (2010) found that French-Arabic bilingual Moroccans showed greater pro-Morocco attitudes when assessed in Arabic as opposed to French. Similarly, Spanish-English bilinguals showed pro-Spanish bias when categorising Spanish and English names. Therefore, when learning another language – particularly in the country with which the language is associated – it is important for an individual to not only acquire specific linguistic knowledge (Regan, Howard, & Lemee, 2009), but it is also important to understand the societal context of the language (Snow, 1999). Such implicit biases towards the in-group are likely to reflect recollection of pertinent cultural memories in the native language (Marian & Kaushanskaya, 2004; Marian & Neisser, 2000; Schrauf et al., 2003), or prime associations and norms characteristic of speakers of the language (Briley, Morris, & Simonson, 2005; see also Danziger & Ward, 2010).

## 1.7 Emotion, culture and social cognition

Whilst the literature linking language and cultural identity is still relatively sparse, a richer bank of knowledge currently delineates the relationship between emotions processing and cultural identity. Before describing this literature, it is perhaps helpful to provide a working definition of 'emotions processing'. Under a cognitive psychology framework, emotions represent a combination of valence and arousal, which facilitates the system that governs an individual's motivational 'approach or avoid' reactions (Bradley & Lang, 1994; Lang & Bradley, 2010).

At the neural level, overlapping networks have evolved for social evaluation, implicating the visual cortex and amygdala (Phelps et al., 2000; Goldin, McRae, Ramel, & Gross, 2008; Ochsner, Bunge, Gross, & Gabrieli, 2000; Damasio et al., 2000), which are also demonstrably involved in the experience of emotions (Adolphs, 2003; Rothbart, 2007; LeDoux, 2012). Although some cognitive accounts of emotion infer that semantic appraisal of an object is necessary for deploying the most appropriate behavioural response to an emotive stimulus (i.e., fleeing from fearful stimuli; Barrett et al., 2007), the majority of theorists appreciate that emotions precede cognitive appraisal (e.g., Lange & James, 1922; Zajonc, 1980; Murphy & Zajonc, 1993). Such a highly interactive system has been shown to lead to emotion-driven biases (Cottrell & Neuberg, 2005; Fiske, Cuddy, Glick, & Xu, 2002).

Several studies show that incidental emotions (also referred to as moods) affect social cognition, not only in terms of our conscious expression of beliefs about others

(for a review see Bodenhausen et al., 2001), but also the implicit, automatic biases we make to social groups (e.g. DeSteno et al., 2004). Specifically, a number of studies now show that incidental emotions arising from external sources unrelated to culture or stereotypical groups influence how we automatically judge and stereotype others, a process known as the carryover of incidental emotion (Bodenhausen, 1993). Moreover, specific types of incidental emotions or moods produce different patterns of bias. For example, 'happiness' has shown to induce a heuristic style of thinking in several domains (e.g., social judgement, decision-making, and persuasion; see Park & Banaji, 2000; Bodenhausen, Kramer, & Susser, 1994a), whilst pride and joy are examples of other emotions ascribed positive valence status, that elicit a more systematic, social-orientated processing style (Haidt, 2003) and are more likely to be internally generated states that outlast the transient emotional circumstances that led to their elicitation (Fredrickson, 2001). Pride, in particular, has been linked to pro-social behaviour (Van Der Schalk, Bruder, & Manstead, 2012). For negative emotions, the effect on judgement is more complex, depending on the specific emotion elicited. Whilst anger also induces a heuristic cognitive style (thought to stem from rapid response to threat, i.e., when an out-group is perceived as a threat to the in-group; DeSteno et al., 2004; Cottrell & Neuberg, 2005; Tiedens & Linton, 2001; Bodenhausen, Sheppard, & Kramer, 1994b), sadness has been shown to induce a more systematic, analytical cognitive style, such that the reliance on stereotypes when judging others is reduced as it is less relevant to inter-group associations (Lambert et al., 1997; DeSteno et al., 2010; Park & Banaji, 2000). Specific emotions act as a context-sensitive

signalling cue, in which certain environmental conditions trigger fast, automatic processing responses that supersede slower, more analytical cognitive styles. This approach is highly adaptive, proving efficient when the environment is optimal (e.g., happy emotions), and a means of defence when there is a threat of danger (e.g., fear emotions; see van Kleef & Fischer, 2016, for a review).

## 1.8 Thesis aims: A meeting point for language, culture and emotion

This review has described the influence of language, culture, and emotions on different cognitive operations – but one striking feature of these studies is that, in most cases, each construct is considered separately. The overarching aim of the current thesis is to examine the interaction between these factors at a high level of cognitive processing. In broad terms, the thesis examines how language and emotions interact to affect semantic and conceptual notions of the self. In each study, bilingual populations are used in order to examine differential behaviour between the first and second language. First, I aim to investigate how each language possessed by a bilingual relates to semantic representations of global and culture-specific knowledge. Second, by manipulating the emotional valence of semantic knowledge relating to the bilingual's native culture, and by considering the role of transient emotional states in modulating social biases, I aim to investigate the role of emotions in mediating language-culture links.

To summarise, this thesis will examine:

1) **Whether** a particular link exists between the native language and semantic knowledge concerning the native culture (Chapter 3), and;
2) **The nature** of this link, with a specific emphasis on long-term, immutable emotional associations (Chapter 4) and short-term, transient emotional states (Chapter 6). I also examine the specificity of the language-culture link as a property of language status in the bilingual mind (Chapter 5)

## 1.9 Chapter summary

In this chapter, I reviewed the current evidence that pertains to the relation between language and cognition, culture and language, and emotions and social cognition. However, this thesis aims to address how these concepts interact to differentially influence thought and behaviour. The following chapter includes an outline of the experimental methodologies implemented, and a description of the bilingual samples recruited for the experiments presented in this thesis.

# Chapter 2

Methodological considerations

## 2.0 Chapter Overview

In this chapter, I will outline the methods used in this thesis. I begin by providing a rationale and overview of how the event related brain potentials (ERPs) presented in Chapters 4 and 5 were collected. I then briefly describe the use of the implicit association test (IAT) and mood manipulation used in Chapter 6. Finally, I describe the samples of bilingual participants who took part in these experiments.

## 2.1 Event-related brain potentials

The electrical activity generated by the brain can be measured non-invasively through the placement of electrodes on the scalp. This voltage is assumed to originate in two sources: from the movement of energy from an axon to the body of a neuron, known as action potentials, and from the fluctuations of energy in the cell membrane due to the influx of neurotransmitters, known as postsynaptic potentials (Stemmer & Whitaker, 2008). The method of recording this signal of electrophysiological activity is known as electroencephalography (EEG). This EEG signal can be obtained due to the differences between each electrode placed on the scalp, and the placement of a reference and ground electrode. The system used in the current thesis recorded EEG activity from 64 electrodes placed on the scalp (**Fig. 1**)

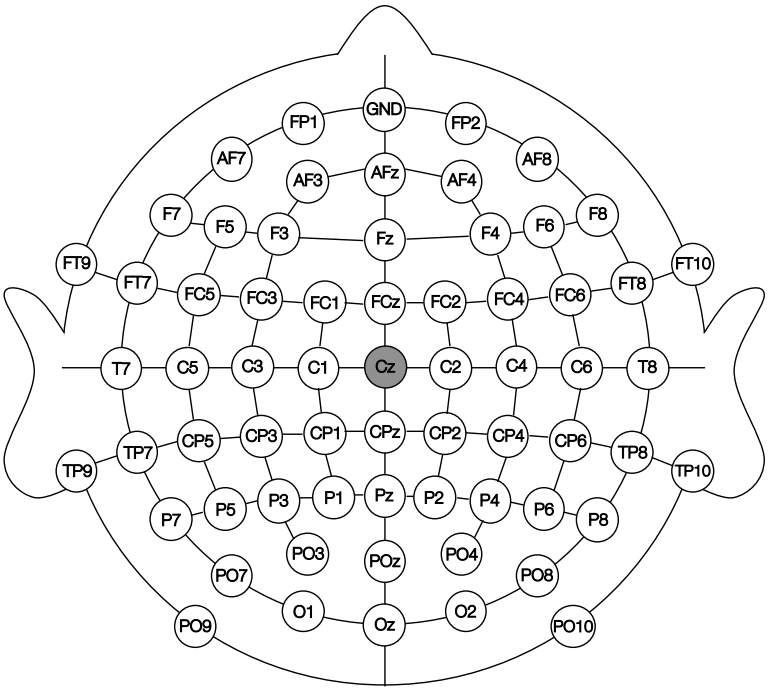


**Figure 1** 64 channel arrangement used in Chapters 3 and 4. The electrode highlighted in grey (Cz) represents the online reference.

In addition to the electrodes shown in Figure 1, four other electrodes were also placed to measure vertical and horizontal eye movements. The muscles involved in the movement of the eyes generate electrical potentials that lead to ocular artefacts in the EEG signal. Therefore it is important to also record this signal in order to be able to mathematically correct the affected data.

In the current set-up, once a connection had been established between each electrode and the scalp via a conductive gel, the electrical activity recorded was amplified and sampled at a rate of 1 data point per millisecond (1kHz), with online filtering using a band-pass filter set between 0.1 and 200 Hz. Following acquisition of the data, further offline filtering of the data was implemented to reduce contamination

from any further sources of electrical noise using a low-pass zero phase shift digital filter with a cut-off frequency of 20Hz. Extreme modulations were removed (+/- 75 μV) and ocular artefacts corrected via a mathematical algorithm proposed by Gratton, Coles, and Donchin (1983). The EEG was then re-referenced to a global average to prevent alteration from any localized electrical artefacts, and to safeguard against topographical asymmetries.

As is common practise in neuroscientific research on language, potentials related to specific stimulus-locked events (ERPs) were derived from the continuous EEG. These ERP epochs ranged from -100 to 1000 ms in relation to the onset of the critical stimulus. These epochs were then averaged across conditions, and then averaged across participants. Subsequent analysis of the data was based on the mean amplitude measured around the peak of interest - the N400. The method of acquiring and analysing the ERP data outlined here is but one of many ways to obtain electrophysiological data.

## 2.2 The N400

ERPs have enabled significant developments in the understanding of language processing (i.e., phonology, syntax, and semantics) by revealing subtle electrophysiological modulations, even in the absence of overt behavioural effects (see Kaan, 2007, for a review). There are several key components that have been identified with regards to language processing: for example, the P1 and N1 are early components that reflect early, low-level perception of stimulus (see Luck, 2014), and later

components such as the P6 reflect processing that involves re-evaluation of stimuli (Osterhout & Nicol, 1999).

Another of these key components is the N4 (or N400 waveform), which is a robust, sensitive, reliable, and widely studied ERP modulation relating to semantic processing (see Kutas & Federmeier, 2011, for a comprehensive review). The component is characterized by a large negative-going wave that typically peaks in the 300-500 ms window, with the effect strongest in central and centro-parietal scalp locations. The N400 can be elicited by a variety of stimuli - including words, pictures, and sounds. In a series of experiments, Kutas and Hillyard (1980a) used sentences and manipulated the final word in order to produce sentences with a congruent (e.g., "*I shaved off my moustache and beard*"), improbable (e.g., "*He planted string beans in his car*"), or incongruent (e.g., "*I take coffee with cream and dog*") ending. The results showed larger N400 amplitudes for the improbable and incongruent endings as compared to the congruent endings. These results were the first to demonstrate the sensitivity of the N400 to semantic violations.

There have since been a plethora of studies establishing that the expectancy of the critical word predicts the degree to which its semantic content is integrated to the preceding context (e.g., Van Berkum, 2009; Brouwer et al., 2012). Moreover, studies have shown that the degree of expectancy is typically quantified in a measure of Cloze probability. In the norming studies typically conducted to establish Cloze probability, participants rate the degree of expectancy on a scale of 0 to 1 (Martin et al., 2013; Kutas & Federmeier, 2011). For example, "She was stung by a wasp" is a plausible

sentence, but the inclusion of the word "wasp" in place of the more highly expected completion "bee" elicited larger N400 amplitude (Kutas & Hillyard, 1984). In the same vein, recent studies have reliably shown that lower Cloze probability values results in greater modulation of the N400 (see Coulson, Urbach, & Kutas, 2006).

The sentences used in this thesis were designed to measure the integration of information based on truth-value, in line with studies that measure violations of real world-knowledge (Nieuwland, & Van Berkum, 2006; Hagoort, Hald, Bastiaansen, & Petersson, 2004). However, we go further by using sentences with semantic violations of a reasonably subtle nature in order to get a sensitive measure of the cultural values held by the individuals.

## 2.3 The Implicit Association Test (IAT)

A behavioural measure that is widely used in the social psychology domain that is also thought to reflect implicit and automatic processing is the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). The IAT provides a measure of the strength of bias or association between a concept (e.g., the commonly studied race bias towards black or white ethnicity) and an attribute (e.g., good or bad). The strength of this bias is measured based on how fast and accurate a concept is paired with an attribute (e.g., white with good), compared to the opposite combination (e.g., white with bad). These effects are thought to be driven by the fast and automatic processing of implicit attitudes (Rydell, McConnell, Strain, Claypool, & Hugenberg, 2007) as compared to cognitively driven explicit biases that are more prone to social

desirability effects (Frith & Frith, 2008). Critics of the IAT such as Hahn, Judd, Hirsh, and Blair (2014) have looked at how participants can predict the strength of their own biases when overtly made aware of the purpose of the categorisation task. Results showed that participants were accurate in predicting their biases, irrespective of their scores on overt measures of bias. These findings suggest that the IAT is susceptible to some overt processing strategies; however, this is a line of inquiry that still warrants further investigation.

However, in this thesis, two versions of the IAT were used: one in Welsh, and the other in English. Crucially, the purpose of the task was not explained to participants until the end of the experiments. Also, in the IAT used here, the attributes presented (e.g., 'clever') were controlled for emotional valence and arousal within- and between-languages, as per Hadden et al. (submitted).

## 2.4 Mood manipulation

Researchers have been examining the most effective way of eliciting emotions in experimental contexts for some time. During this period, a number of emotion elicitation processes have been used such as music, imagery, and autobiographical memory recollection, to name but a few (see Gross & Levenson, 1995, for a review).

To this end, social psychology studies have shown that moods affect social cognition, not only in terms of conscious expression of beliefs about others (for a review see Bodenhausen et al., 2001), but also the implicit, automatic biases made to social groups (e.g. DeSteno et al., 2004). Specifically, a number of studies now show

that incidental emotions arising from external sources unrelated to culture or groups influence the automatic judgements and stereotypes of others, a process known as the carryover of incidental emotion (Bodenhausen, 1993). Thus, in this process, it is important to select a mood elicitation method that does not overtly invoke cultural connotations. Methods such as masked priming of emotional words (Gaillard et al., 2006) although implicit in emotional nature, may evoke linguistic associations that are rooted in one's culture. In the same vein, using feedback could have provoked socially driven emotions due to the social interaction involved in communicating valenced verbal feedback (Pedersen, Bushman, Vasquez, & Miller, 2008).

As well as mood states being considered as a form of emotion that is context-independent (e.g., Egidi & Nusbaum, 2012), we decided to elicit transient emotional states with emotional film clips. Moreover, we ensured that they did not include any linguistic cues so that emotions would originate outside the linguistic domain, and therefore would not produce language-specific associations. Thus in the absence of engaging linguistic information, we coupled the videos with music that suited the emotional tone of the videos, i.e. happy or sad, in order to elicit a suitable level of emotional state. Music has often been used in this way, and has been shown to be effective at influencing moods for short periods of time (Pedersen, Bushman, Vasquez, & Miller, 2008; Avramova & Stapel, 2008). See Chapter 6 for details of the precise content of the video clips.

## 2.5 Participants

The topic of National identity has been of great importance in Wales for some time, especially to those who can speak the language. It is estimated that only around 19% of the general population can speak Welsh. However, the use of Welsh in regions of North-West Wales is much more prevalent, with rates of first-language speakers being as high as 86% in some areas (e.g., Caernarfon; Office for National Statistics, 2011). Moreover, for many people living in Wales, the ability to speak Welsh is seen as a marker of cultural identity (Williams, 2009), therefore, whereas Welsh signifies the in-group, the English language represents alignment with the out-group. The Welsh Language Society attests the current language landscape to roots in the wider historical context of the conflict between Wales and England (Cymdeithas Yr Iaith Gymraeg; as cited in Livingstone, Spears, Manstead, & Bruder, 2009):

> 'Wales is one of the many small nations of Europe which have been historically deprived of the right to self-determination. Our country was annexed to England in 1536 by an Act of (England's) Parliament. The important thing now is to build a 'culture of resistance' against those forces that are destroying our language and our identity. This means a struggle for radical change' (pp. 755)

Fitz (2000) goes further by attributing this sense of threat to the influence of English culture and the influx of English speaking individuals into traditional Welsh-speaking communities (Cloke, Goodwin, & Milbourne, 1998), furthermore, Bourhis and Giles (1976) argue that such perceived threats to cultural identity evoke defensive mechanisms.

Therefore, bilingual individuals living in North-West Wales are an extremely appropriate sample for investigating the interactions between language, culture, and emotion in the context of this thesis. Moreover, the vast majority of these bilinguals are fluent in their second language, English (Gathercole, 2007), which is essential for the experimental constraints. That is, in these experiments I present information in both languages of the bilingual, in the form of matched translation equivalents. This is an important factor in order to be able to make inferences as to the full effect of language in the different experimental conditions presented in this thesis. Moreover, the language dominance of these non-immigrant bilinguals was also tested in Chapter 5, whereby bilinguals' dominant language and native culture was incongruent.

## 2.6 Chapter summary

In this chapter, I discussed the methodological considerations of this thesis. I discussed the acquisition of ERPs, and the component of interest included in two studies reported here, I also gave an overview of the IAT and mood manipulation procedure, and finished by discussing the samples of bilinguals recruited. In the next four chapters of this thesis, I will present four experiments investigating the interaction between language, culture, and emotions: Chapter 3 and 4 will describe ERP studies, Chapter 5 will describe the results of a behavioural study, and Chapter 6 will include the use of the IAT and mood manipulations. These experimental chapters have been presented in a manner that would make them suitable for publication. Chapter 3 is currently published in *Social, Cognitive and Affective Neuroscience*, and

Chapter 4 is currently being considered for publication in the same journal. A version of Chapter 6 will soon be submitted to *Psychological Science*.

# Chapter 3

## Language and culture modulate online semantic processing[1]

[1] This chapter appears in print:
Ellis, C., Kuipers, J. R., Thierry, G., Lovett, V., Turnbull, O., & Jones, M. W. (2015). Language and culture modulate online semantic processing. *Social Cognitive and Affective Neuroscience, 10,* 1392-1396.

## Abstract

Language has been shown to influence non-linguistic cognitive operations such as colour perception, object categorisation, and motion event perception. Here, we extend this investigation to specifically focus on the impact of culture-specific conceptual representations and linguistic context on semantic processing. Using event-related brain potentials, we show that highly fluent Welsh–English bilinguals require significantly less processing effort when reading sentences in Welsh which contain factually correct information about Wales, than when reading sentences containing the same information presented in English. Crucially, culturally irrelevant information was processed similarly in both Welsh and English. Our findings show that even in highly proficient bilinguals, language interacts with factors associated with personal identity, such as culture, to modulate online semantic processing.

## 3.1 Introduction

Recent research has shown that language affects basic cognitive functions such as perception and object categorisation (Thierry et al., 2009; Boutonnet, Athanasopoulos, & Thierry, 2012), thus making large strides in resolving the contentious debate surrounding the influence of language on human cognition (Whorf, 1956; Lakoff, 1987; Hunt & Agnoli, 1991; Bowerman & Levinson, 2001; Levinson, 2003). At higher levels of conceptual representation, it is commonly accepted that the semantic level is shared across all languages spoken by an individual (De Groot, 1992; Kroll & Stewart, 1994; La Heij et al., 1996; Van Hell & De Groot, 1998; Gollan & Kroll, 2001). However, recent evidence suggests that the language of operation also affects higher-level representations, as is the case in the domain of lexically-driven semantic associations (Boutonnet, McClain, & Thierry, 2014) and motion conceptualisation (Kersten et al., 2010; Athanasopoulos et al., 2015). Here, we provide the first empirical, neurophysiological evidence that the language in which someone operates can modulate highly complex semantic representations derived from personal identity and cultural stereotypes.

Behavioural studies have shown that language shapes conceptual information. Abstract linguistic idiosyncrasies, such as arbitrary male-female gender marking, influence the perception of semantically gender-neutral objects (Boroditsky, 2001; Boroditsky, Schmidt & Phillips, 2003), and the effect of factors relating to personhood, such as cultural biases induced by native personal pronouns, is heightened when information is presented in the native language (see Danziger & Ward, 2010;

Ogunnaike et al., 2010). However, such findings remain sparse and limited to single nouns and pronouns. The link between language and personhood, which is a defining feature of culture, may therefore be redolent of phenomena such as the implicit activation of racial attitudes and biases (see Fiedler, Messner, & Bluemke, 2006, for a critique of the Implicit Association Task [IAT]), but it remains unknown whether the languages spoken by an individual each interact differently with culture to affect 'comprehension'. This distinction is important, in that evocation of attitudes is generally conceived as an automatic, "knee-jerk" reaction to a stimulus, whereas comprehension refers to semantic analysis, synthesis and understanding of linguistic information.

In this study, we tested whether language and cultural factors may interact to modulate sentence comprehension in fluent, early adult Welsh-English bilinguals. We recorded electrophysiological responses in bilingual participants reading Welsh and English sentences. Half of the sentences in each language contained culturally relevant information; the other half referred to culturally non-relevant facts, i.e., generic semantic knowledge. Furthermore, and in order to implement a suitable cognitive task, half of the sentences formed a true premise and the other half a false one (see Table 1). Semantic processing was indexed by the amplitude of the N400 wave of the event-related potential (ERP) elicited by the sentence-final word, identical between experimental conditions. N400 amplitude is modulated by the extent to which the target word fits the semantic context in which it is presented, with increasing negative amplitude indexing greater energy required for semantic integration (Kutas &

Federmeier, 2011). Current theorising on N400 modulation implicates lexical retrieval from long-term memory, which is facilitated by top-down context information from the preceding sentence fragment (e.g., Van Berkum, 2009; Brouwer, Fitz, & Hoeks, 2012). In the current experiment, participants pressed buttons to indicate whether each presented statement was true or false, thus providing a direct measure of sentence comprehension. We predicted reduced N400 amplitudes for words completing a true statement as compared to these same words completing a false statement by virtue of the fact that true statements are naturally more expected than false ones. We further hypothesised a differential effect of language for culturally–relevant content, and thus expected to find an interaction between language and cultural relevance. More specifically, we anticipated a greater true-false N400 disparity for information about Wales or the Welsh people presented in Welsh as compared to the same information presented in English. Such an interaction would indicate that semantic processing is indeed different in the two languages insofar as they shed a different light on culturally relevant information.

## 3.2 Materials and Methods

### 3.2.1 Participants

Eighteen balanced Welsh-English bilinguals with normal or corrected vision (1 male; 17 females; $M_{age}$ = 22.06, $SD$ = 5.03) were included in the analysis. Five participants were excluded because they had too few artefact-free epochs per condition. Participants self-reported that they were L1 Welsh speakers, having been exposed to

English from an early age (*M* = 4.22 years; *SD* = 2.88). The sample reported, on average, 66% L1 and 34% L2 usage in everyday interactions, including bilingual educational instruction. Ethical approval was granted by the School of Psychology, Bangor University ethics committee, and participants gave written consent.

### 3.2.2 Stimuli and procedure

A total of 40 English sentence sets and 40 Welsh translation equivalents were constructed. In each language, each set consisted of 8 sentences ending in the same final word. Participants were presented with 4 sentences from the English set, and 4 different sentences from the Welsh set (**see Table 1**, *a* and *b*). Thus, for any given participant, each experimental sentence was not repeated, not even by way of a translation equivalent. Of these sentences, the language factor (English vs. Welsh) was crossed with a cultural relevance factor (relevant vs. non-relevant) and a truth-value factor (true vs. false). The procedure included two important counterbalancing features: (i) The truth-value (true vs. false) of sentences containing a particular referent (e.g., 'instruments') was inverted between languages of presentation, (ii) The language of sets *a* and *b* was fully rotated between participants.

**Table 1** Experimental design and example of a statement 'set'

| **Set a** | Truth-value | Relevance |
|---|---|---|
| Every single Welsh child can sing in ***tune.*** | False | Relevant |
| Opera at the National Welsh Theatre is always in ***tune.*** | True | |
| Good quality antique instruments always stay in ***tune.*** | False | Non-relevant |
| Before a professional concert, a piano is always in ***tune.*** | True | |
| **Set b** | Truth-value | Relevance |
| The National Welsh Theatre is the only venue where opera is in ***tune.*** | False | Relevant |
| A lot of Welsh children can sing in ***tune.*** | True | |
| The piano is the only instrument that stays in ***tune.*** | False | Non-relevant |
| Old instruments are quite likely to be out of ***tune.*** | True | |

In a separate pre-test, 20 participants who did not take part in the experiment proper were asked to complete the sentences with the first three words that came to mind. If one of the completions matched our experimental sentences, a score of 1 was given. All other answers were given a score of 0. When scores were averaged across sentences, a cloze probability of 42% was obtained, which was above our threshold of 40% (Coulson et al., 2006), and there was no significant difference between conditions ($p > .05$). Sentence-final target words were controlled for written frequency, word and syllable length ('Cronfa Electroneg o Gymraeg' [Welsh], Ellis et al., 2001; CELEX lexical database [English], Baayen, Piepenbrock, & Van Rijn, 1993). Each participant thus read 320 sentences in total presented in 8 experimental blocks.

Stimuli were presented in white courier new 18-point font on a black background on a 19-inch CRT monitor with a refresh rate of 75Hz. The first clause of

each sentence was presented all at once and reading was self paced, followed by single word presentations in the centre of the screen for 200ms with an inter-stimulus interval of 500ms (so as to prevent eye movements upon presentation of the final word). Presentation order was pseudorandomised such that participants would not encounter the same final-word within the same block. Following each sentence, participants made a yes/no judgement regarding the truth-value of each statement.

### 3.2.3 Electrophysiological recording

Electrophysiological data were recorded from 64 Ag/AgCl electrodes according to the extended 10-20 convention; referenced to the Cz electrode at a rate of 1 kHz. Impedances were kept below 5 kΩ. Electroencephalogram (EEG) activity was filtered online with a band-pass filter between 0.1 and 200 Hz and offline using a low-pass, zero phase shift digital filter with a cut off frequency of 20 Hz. Eye blink artefacts were corrected mathematically using the procedure proposed by Gratton, Coles, and Donchin (1983), and remaining artefacts were removed manually upon visual inspection of the data. Epochs ranged from -100 to 1000 ms after final word onset. Epochs with activity exceeding ±75μV at any electrode site over the scalp were discarded. Baseline correction was performed in reference to pre-stimulus activity and individual averages were digitally re-referenced to the global average reference.

## 3.3 Results

Analyses were conducted on 79% of the data, i.e., sentences that were accurately verified as true or false (cf. Martin et al., 2014). Repeated measures ANOVAs were conducted with Language (Welsh vs. English), Cultural relevance (relevant vs. non-relevant), and Truth-value (true vs. false) as independent variables.

### 3.3.1 Behavioural data

ANOVA analyses on *reaction time* data yielded no main effects of Cultural relevance ($F_{(1, 17)} = 1.15$, $p > .05$), Language ($F_{(1, 17)} = 0.35$, $p > .05$), or Truth-value ($F_{(1, 17)} = 1.23$, $p > .05$). A Language by Truth-value interaction ($F_{(1, 17)} = 4.81$, $p = .042$) showed that in the case of Welsh sentences, true statements were responded to more quickly than false ones, whereas statements in English were responded to with similar speed independent of truth-value. There was also a Language by Cultural relevance interaction ($F_{(1, 17)} = 10.71$, $p = .004$) such that culturally relevant statements were responded to more quickly than non-relevant statements when sentences were presented in Welsh but no such difference was found for statements in English. No other interactions emerged from the reaction time data (see **Fig. 1**). A correlation analysis by-subjects revealed no evidence of a speed-accuracy trade off ($r$ (1, 18) = .09, $p = .73$).

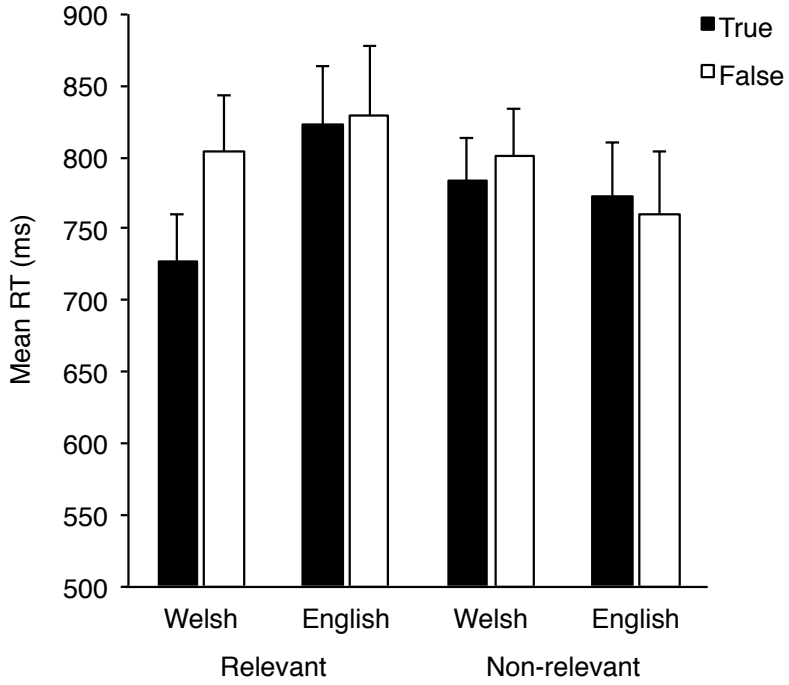


**Figure 1** Mean RTs (ms) for correct true / false responses to culturally relevant or non-relevant statements presented in Welsh or English. Error bars represent SE of the mean.

### 3.3.2 Electrophysiological data

We analysed ERP amplitudes over 10 electrodes over which the N400 is known to be maximal (linear derivation of Cz, C1, C2, C3, C4, CPz, CP1, CP2, CP3, CP4; Kutas & Hillyard, 1980a, 1980b, 1984; Hoshino & Thierry, 2012; Martin et al., 2009; see also Kutas & Federmeier, 2011; Luck, 2014, p. 52) (Fig 2). As expected, there was a main effect of Truth-value ($F_{(1, 17)} = 19.65$, $p < .001$), such that the N400 was reduced in amplitude for true relative to false statements and no other main effects (Cultural relevance: $F_{(1, 17)} = 1.71$, $p > .05$; Language: $F_{(1, 17)} = 1.43$, $p > .05$) or two-way interactions (Language and Truth: $F_{(1, 17)} = 1.35$, $p > .05$; Language and Culture: $F_{(1, 17)} = 2.28$, $p > .05$; Truth and Culture: $F_{(1, 17)} = 1.34$, $p > .05$) emerged.

Critically, we found a significant three-way interaction between Language, Cultural relevance and Truth-value ($F_{(1, 17)} = 6.01$, $p = .025$). Planned comparisons on the N400 effect (True – False) in the different conditions showed that the N400 was significantly larger for Welsh than English in the culturally relevant conditions ($t(17) = 3.12$, $p = .006$; **Figs. 2** and **3**), whereas no language difference was found for culturally non-relevant sentences ($t(17) = -0.95$, $p > .05$).

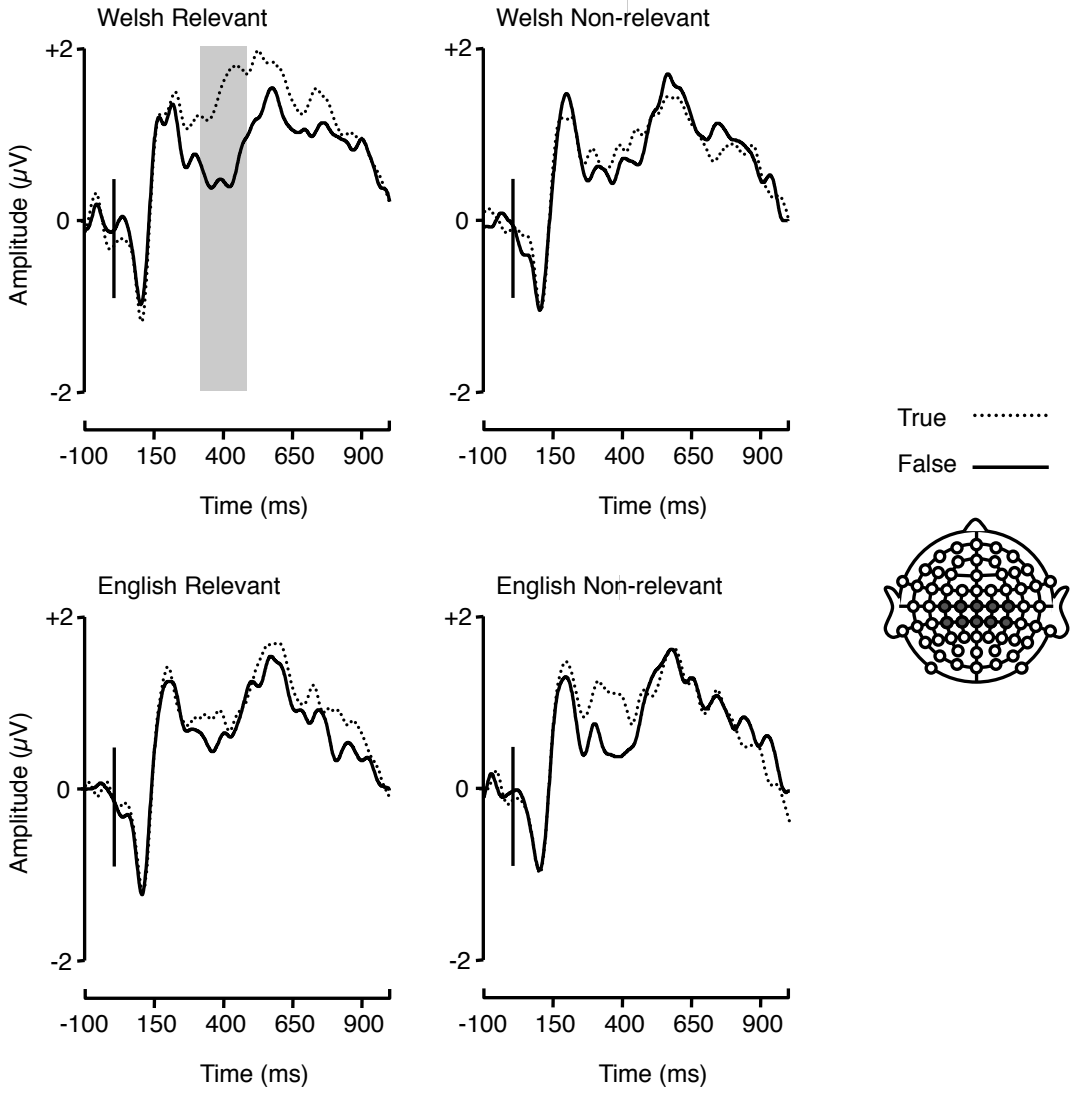


**Figure 2** ERPs elicited by true / false sentences containing culturally relevant or culturally non-relevant information and presented in either Welsh or English. The shaded area indicates the window of analysis in which mean ERP amplitudes significantly differed between conditions (340-450 ms post-stimulus).

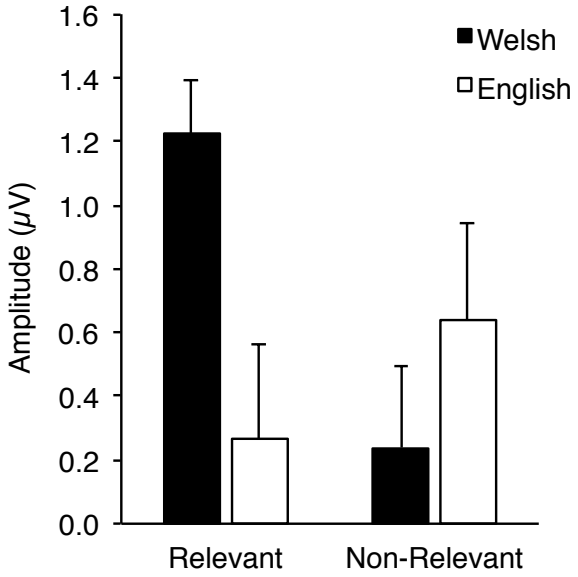


**Figure 3** Mean amplitude (μV) of the N400 effect (True-False) for culturally relevant and non-relevant statements presented in Welsh or English. Error bars represent SE of the mean.

Overall, our results show that for statements containing information about Wales the N400 effect is larger when these statements are presented in Welsh than in English. Importantly, this finding is not due to a generic/overall preference for the Welsh language because no language differences were found for general statements.

## 3.4 Discussion

We investigated whether the language we speak can influence the way in which we understand detailed, sentence-level information, using the N400 ERP wave as an index. Our findings indicate that language interacts with cultural identity during semantic processing. More specifically, we show that true, culturally relevant information about Wales is integrated with more ease when it is presented in Welsh

than in English, even though English translation equivalents are supposed to convey identical information. In contrast, culturally non-relevant information is not processed differently between languages. To our knowledge, this is the first demonstration that information intimately linked with the native language (e.g., because of the emotional context in which knowledge is acquired) is processed more readily in that language than in another language acquired subsequently. Language therefore affects cognition even at the subtlest levels of semantic knowledge.

It is noteworthy that the ERP modulations reflecting online semantic processing at 400 ms post stimulus were broadly consistent with behavioural RT sentence-verification data acquired simultaneously: Factually correct and culturally relevant information yielded shorter RTs, supporting the interpretation of easier semantic processing when language and cultural references are aligned.

We believe that these findings significantly extend insights into linguistic relativity effects. Previous electrophysiological studies have shown an influence of language on basic cognitive functions such as perception and object categorisation (Thierry et al., 2009; Athanasopoulos et al., 2010; Boutonnet et al., 2013). Furthermore, emotional words have been shown to have a different resonance or impact in the first and second language of bilinguals (Dewaele, 2004; Wu & Thierry, 2012) but the effect of language on higher-order levels of semantic processing such as cultural relevance has seldom been observed. Recent studies using the Implicit Association Task (IAT) suggest that language and culture interact in complex ways (Danziger & Ward, 2010; Ogunnaike et al., 2010). In both studies, bilinguals showed

faster responses to native personal pronouns paired with positive adjectives (such as "good") when the task was performed in the native relative to the non-native language. The authors concluded that language serves as a cue for the activation of certain racial biases (see Briley, Morris, & Simonson, 2005; Danziger & Ward, 2010).

Our study also shows that the languages spoken by a bilingual do not equally convey cultural mores, such that a statement may not be understood in the same way at all depending on its reference to the speaker's native culture. Thus, linguistic relativity is not confined to automatic reactions defining attitudes, prejudice or belief (Briley et al., 2005). 'False' statements in our study involved fairly subtle misinformation, conforming to folk wisdom and national pride (e.g., *Welsh collies are the most intelligent breed of dog*). However, the N400 for false, culturally relevant statements presented in Welsh was not attenuated in the same way as true, culturally relevant statements presented in Welsh. Thus, our findings suggest that language specifically influences online processing of real, verifiable semantic knowledge when it relates to culturally relevant information. Importantly, any modulation of the N400 in this study must have originated from the language used, since the semantic sentence context and critical final word were identical across language conditions (see Kutas and Federmeier, 2011). We also note here that the duration of the N400 was sustained beyond the usual range (typically ~ 250-550ms, e.g., Kutas & Hillyard, 1980b; Hagoort et al., 2004), which is perhaps to be expected given the relative subtlety of our true/false manipulation, leading to prolonged content evaluation or decision making

processes (Hagoort, 2003; Hagoort, Wassenaar, & Brown, 2003; Osterhout & Nicol, 1999; Martín-Loeches et al., 2006).

To conclude, our study provides the first neurophysiological demonstration that the language we speak interacts with personal factors such as cultural identity to modulate online semantic processing during sentence comprehension, one of the most sophisticated cognitive abilities of the human brain. The mechanism underlying these effects remains unknown, but is likely to involve episodic memory and the limbic system, both of which are known to be shaped by one's cultural experience (Danziger & Ward, 2010; Marian & Kaushanskaya, 2004; Marian & Neisser, 2000; Schrauf, 2000). Future studies will hopefully shed more light on the existence and permanence of these effects across development and in bilingual adults with varying degrees of proficiency.

# Chapter 4

## Languages flex cultural thinking[2]

[2] This paper is under review in *Social, Cognitive, and Affective Neuroscience* as:
Ellis, C., Thierry, G., Vaughan-Evans, A., & Jones, M. W. Languages flex cultural thinking.

## Abstract

Recent studies have revealed remarkable interactions between language and emotion. Here, we show that such interactions affect the accuracy of truth-judgments made regarding culturally relevant information and that the locus of this modulation is semantic. Balanced Welsh-English bilinguals were asked to categorise statements about their native Welsh culture as true or false. Whilst participants categorised *positive* statements as true when they were true, they were biased towards categorising them as true also when they were false, irrespective of the language in which they read them. Furthermore, whilst participants showed the anticipated reverse bias for *negative* statements read in English – that is, a tendency to categorise true negative statements as false – they were surprisingly unbiased in their native language, Welsh. Based on modulation of the N400 peak of event related brain potentials, we identified the source of this behaviour as originating in online semantic evaluation of the statements. These findings suggest that bilinguals perceive and react to culturally relevant information in a language-dependent fashion. When faced with detrimental reference to their culture, bilinguals appear to be more disconcerted in their native language, causing them to defend themselves less efficiently.

## 4.1 Introduction

Recent evidence has shown that language affects basic aspects of human cognition (Boroditsky, Schmidt, & Phillips, 2003; Boutonnet, Athanasopoulos, & Thierry, 2012; Thierry et al., 2009). Recent data moreover show the impact of culture-specific conceptual representations and linguistic context on the processing of objectively verifiable information (Ellis et al., 2015) as well as subjective beliefs and cultural stereotypes (Briley, Morris, & Simonson, 2005; Danziger & Ward, 2010; Ogunnaike, Dunham, & Banaji, 2010). Language that refers to cultural membership is often emotionally laden. For example, the word "foreigner" in English is derived from the Latin "person outside", and by speaking the word, one aligns oneself, however temporarily, with a specific in-group (Ogunnaike et al., 2010).

How can the bilingual mind then accommodate different perspectives, which originate from the different languages spoken? Previous research suggests privileged access to emotions from the native language (L1; Altarriba, 2008; Dewaele, 2004; Pavlenko, 2008), and recent studies have shown interactions between language and emotion at the highest levels of human cognition. For instance, unconscious access to L1 when bilinguals read in their second language (L2; Thierry and Wu, 2007) is repressed when words have a negative valence (Wu & Thierry, 2012). Furthermore, risk-taking behaviour tends to be more impulsive and subject to a greater intuitive bias in L1 than in L2 (Costa et al., 2014; Gao et al., 2015; Keysar, Hayakawa, & An, 2012).

Here, we examined how Welsh-English bilinguals react to affective information concerning their native culture, when operating in their first (native) or their second

language. Participants read objectively true and false statements that present Wales, and Welsh culture, in either a positive or a negative light, written either in Welsh or English, and made truth-value judgments. We expected that our Welsh native participants would be biased towards assessing positive statements about Welsh culture as true, regardless of truth-value and we expected them to show the reverse bias for negative statements. Furthermore, we expected that these biases would be more pronounced in their L1 Welsh than L2 English. We used event-related brain potentials (ERPs) to validate the locus of the effect at a semantic level based on modulations of the classical N400 peak (Kutas and Hillyard, 1980a, 1980b). We also assessed potential links between behavioural observations and semantic integration by means of correlation analyses.

## 4.2 Materials and Methods

### 4.2.1 Participants

Sixteen highly proficient Welsh-English bilinguals (14 females; $M_{age}$ = 22.56 yrs, $SD$ = 7.17) were included in the final analyses. Five participants were excluded due to poor data quality. All participants were right-handed, had normal or corrected-to-normal vision, and reported no language impairments. All participants had been exposed to the Welsh language from birth, had acquired English at an early age ($M$ = 5.13, $SD$ = 3.16), and thus were all early, fluent Welsh-English bilinguals. Participants' self-ratings of language proficiency (on a scale of 1 = not literate, to 10 = very literate) for reading, writing, speaking and comprehension were high for both Welsh ($M$ = 9.16, $SD$ = 1.48)

and English ($M$ = 8.64, $SD$ = 1.25). Participants self-reported more daily use of Welsh ($M$ = 74.69%, $SD$ = 18.02) than English ($M$ = 24.69%, $SD$ = 18.39; $p < 0.0001$). The Multigroup Ethnic Identity Measure (MEIM; Phinney, 1992, Roberts et al., 1999) revealed a strong sense of Welsh cultural belonging ($M$ = 3.40, $SD$ = 0.50, α = .88: 1 = indifferent response to 4 = strong cultural response). Participants provided informed consent and took part in the experiment in return for payment or course credits. Ethics approval was granted by the School of Psychology ethics committee at Bangor University.

### 4.2.2 Stimuli

Three hundred and twenty statements in English and their Welsh translations were constructed. Within each language, the statements were divided into 40 sets of 8, which ended in the same final word. Participants were presented with four statements from the English sets, and four statements from the Welsh sets that were not the translation of the English selection (**Table 1**). Thus, for any given participant, experimental sentences were never repeated, not even by way of translation. Therefore, the experimental design involved three factors: Language (English, Welsh), emotional Valence (positive, negative), and Truth-value (true, false). Valence and Truth-value were counterbalanced across languages.

**Table 1** Experimental design and example of a statement 'set'

| **Set a** | Truth | Valence |
|---|---|---|
| Wales has the richest, most affluent community of ***farmers.*** | False | Positive |
| A deeply Welsh and noble way of life is represented by our ***farmers.*** | True | |
| In Wales, supermarkets get the cheapest milk directly from ***farmers.*** | False | Negative |
| Young Welsh people are discouraged from becoming ***farmers.*** | True | |

| **Set b** | Truth | Valence |
|---|---|---|
| Young Welsh men become very rich in their careers as ***farmers.*** | False | Positive |
| The highest quality lamb meat in Britain is produced by our ***farmers.*** | True | |
| A shameful way of life is represented by our ***farmers.*** | False | Negative |
| Wales has a problem with poverty in some communities of ***farmers.*** | True | |

### 4.2.3 Norming of stimuli

Twenty balanced Welsh-English bilinguals ($M_{age}$ = 27.15 yrs, $SD$ = 12.87; 100% reported L1 Welsh) participated in a separate pre-test to validate statements for valence, and Cloze probability. Prior to the norming study, three native speakers of Welsh independently verified statements as true or false, and only statements yielding full agreement were included in the study. Cloze probability was measured by asking participants to provide the first three possible completions they could come up with for each statement. Completion words had a mean Cloze probability of 52%, which was significantly above the recommended threshold of 40% (Coulson, Urbach, & Kutas, 2006), and it did not differ between conditions (all $ps > 0.05$). Target words were controlled for lexical frequency and word length in both Welsh and English (Welsh: Cronfa Electroneg o Gymraeg, Ellis et al., 2001; English: CELEX lexical database, Baayen, Piepenbrock, & van Rijn, 1993). Statement valence was assessed (on

a scale from 1 = positive to 7 = negative) in line with expectations (Positive Welsh: $M$ = 1.91, $SD$ = 0.43; Positive English: $M$ = 1.99, $SD$ = 0.52; Negative Welsh: $M$ = 6.28, $SD$ = 0.17; Negative English: $M$ = 6.19, $SD$ = 0.41; $F$ = 1684, $p < 0.0001$, $\eta_p^2$ = .99) but, critically, there was no difference in valence by Language ($p$ = 0.702) or Truth ($p$ = 0.510).

### 4.2.4 Procedure

Stimuli were presented at the centre of a 19-inch cathode ray tube (CRT) monitor with a refresh rate of 75 Hz, in white, courier new, 18-point font on a black background using E-prime 1.0 software. Reading of the first clause of each statement was self-paced, followed by single-word presentation of the final clause at a rate of 200 ms per word and an inter-stimulus interval of 500 ms (**Fig. 1**)

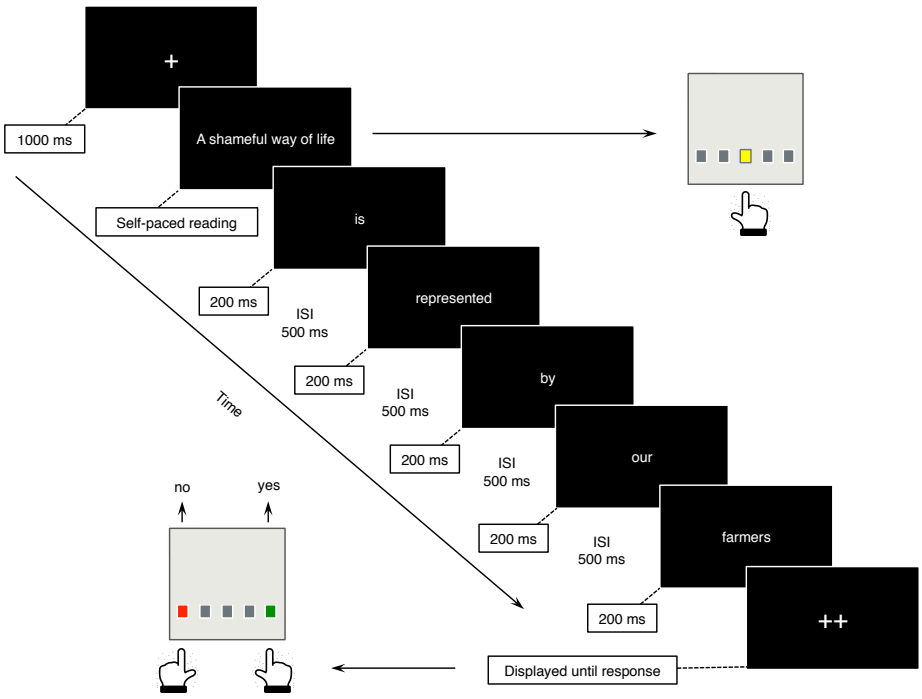


**Figure 1** Structure of an experimental trial.

Following the presentation of the final word, participants were presented with a fixation cross, before being prompted by a 'double plus' sign to make a true/false judgment by pressing designated buttons. The prompt remained on screen until response. Participants were briefed verbally at the outset of the experiment to make the true/false judgment as quickly as possible following the prompt. Three practice trials preceded the experimental trials. The experiment was divided into 8 blocks for presentation, with short breaks between each block. The order of presentation was pseudorandomised, such that participants would not encounter the same final word twice within a given block. Blocks were randomised within-language, and language order was counterbalanced across participants.

### 4.2.5 Behavioural data analysis

Accuracy and reaction times (RT) were modelled as a function of three within-participant factors: Language (Welsh, English), Valence (positive, negative), and Truth (true, false). For accuracy data, a binomial logistic regression was implemented. RT data were log transformed and examined with linear mixed effects analyses. All analyses were conducted using R (R Development Core Team, 2008) using the lme4 library (Bates, Maechler, & Dai, 2008; Baayen, 2008). $\beta$-values are reported, and tested at $p < 0.05$.

### 4.2.6 ERP analysis

Electroencephalogram activity was continuously recorded from 64 Ag/AgCl electrodes according to the extended 10/20 convention, referenced to Cz at a rate of 1 kHz. Impedances for all electrodes were kept below 5 kΩ. The EEG was filtered online, with a band-pass filter between 0.1 and 200 Hz and re-filtered offline using a low-pass zero phase shift digital filter with a cut-off frequency of 20 Hz. Both EEG and behavioural data were collected simultaneously. Eye blink artefacts were corrected mathematically (based on an algorithm developed by Gratton, Coles & Donchin, 1983), and remaining artefacts were removed manually upon visual inspection of the data using Scan 4.4 software (Neuroscan, Inc.). Epochs ranged from −100 to 1000 ms after final word onset, and any activity exceeding ± 75 μV at any electrode site over the scalp was discarded. Baseline correction was performed in reference to pre-stimulus activity and individual averages were digitally re-referenced to the global field power. ERPs time-locked to the final word of each statement were visually inspected, and mean amplitudes were measured in temporal windows determined based on variations of the mean global field power measured across the scalp (Picton et al., 2000). As predicted, the N400 was maximal over central electrodes (C1, Cz, C2, CP1, CP2, CPz; Kutas & Hillyard, 1980; Hagoort et al., 2004).

## 4.3 Results

### 4.3.1 Behavioural results

For accuracy data (**Fig. 2a**), the full (Language*Truth*Valence) interaction model was found to provide the best fit for the data, compared with lower-order interaction models, $X^2 = 274.63$, $df = 10$, $p < 0.0001$ (Barr et al., 2013). Including a by-subject random slope for each of the factors Language, Truth and Valence led to non-convergence in the model, so we simplified the final model to include random intercepts for subjects and items. Collinearity was not an issue in this model: Fixed-effects correlations ($|r|$) were less than 0.7 for all predictors. The intercept represents the average likelihood that participants were accurate in the English/Positive/False condition. Each coefficient compares the average for a different combination of fixed factor levels against this intercept.

As expected, participants displayed a bias for positive statements, such that true statements were accurately categorised, whereas false statements were miscategorised as true ($b = 1.40$, $z = 10.59$, $p < 0.0001$). Accuracy was moreover comparable in English and Welsh, both for false statements ($b = -0.05$, $z = -0.46$, $p = 0.641$) and true statements ($b = 0.05$, $z = 0.29$, $p = 0.770$). Also as expected, participants displayed a reverse bias in response to negative statements, such that they were more likely to accurately categorise false statements ($b = 1.32$, $z = 9.55$, $p < 0.001$), whereas true statements tended to be miscategorised as false ($b = -2.44$, $z = -13.15$, $p < 0.001$). Contrary to our hypotheses, however, negative statements read in Welsh did not elicit a similar bias: Participants tended to be less accurate in rejecting false statements ($b = -0.51$, $z = -2.94$, $p = 0.003$) and more likely in accepting true statements ($b = 0.86$, $z = 3.37$, $p < 0.001$).

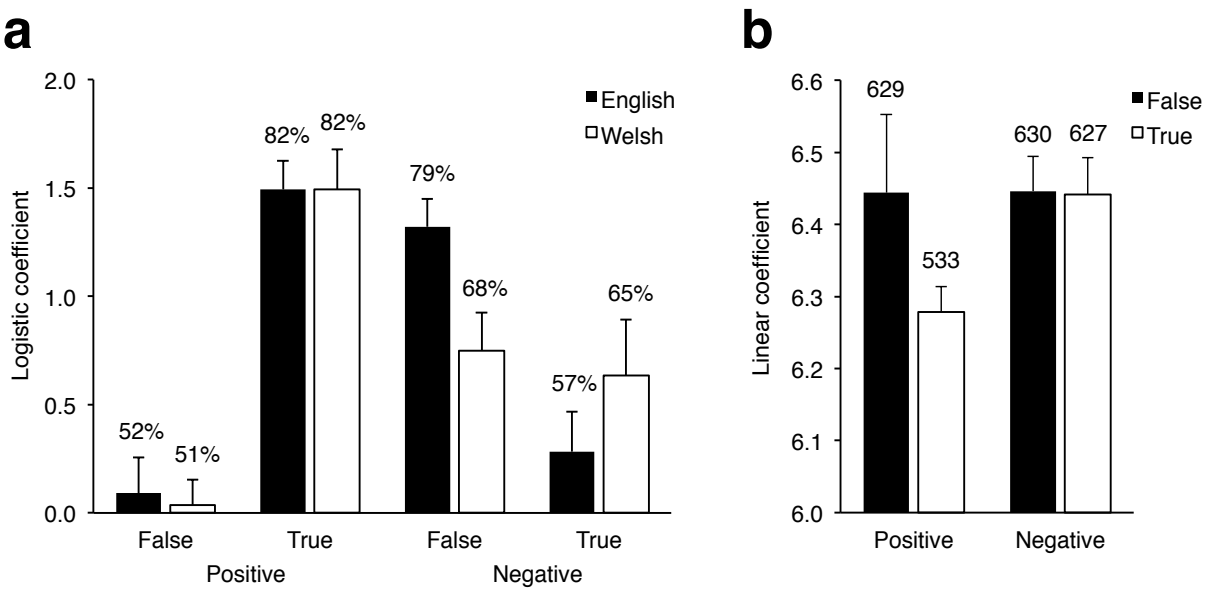


**Figure 2** Behavioural results. **(a)** Accuracy scores (average % provided above each bar) for truth judgments as a function of Language and Truth, split by Valence. **(b)** Reaction Times (average provided above each bar) for truth judgments as a function of Truth and Valence. Errors bars represent SEs.

Participants' RT data (**Fig. 2b**) showed that a lower order interaction model (Language+Truth*Valence) contributed unique variance beyond the additive model ($X^2 = 12.71$, $df = 6$, $p = 0.022$). The model included by-subjects intercepts and slopes (1+Language+Truth*Valence|Participant), and the by-item intercept (1|Item). Fixed-effects correlations ($|r|$) were less than 0.7 for all predictors. The intercept represents the average estimated RT in the English/Positive/False condition.

For positive statements, participants were faster to respond to true than false information ($b = -0.16$, $t = -3.43$, $p = 0.001$), and response time was identical in English and Welsh ($b = 0.08$, $t = 0.89$, $p = 0.372$). Participants' RT to false information did not differ between negative and positive statements ($b = 0.00$, $t = 0.06$, $p = 0.948$),

whereas responses to true information were significantly slower ($b = 0.16$, $t = 3.11$, $p = 0.002$).

### 4.3.2 Electrophysiological results

We analysed modulation of the N400 mean amplitude (between 300-500 ms post stimulus onset). In a first pass analysis, trials were sorted based on absolute truth-value irrespective of accuracy ($M = 38$ trials per condition, $SD = 2$). We found a main effect of Truth ($F_{(1,15)} = 5.67$, $p = 0.030$), such that false statements elicited greater negativity relative to true statements (**Fig. 3**). No other effects emerged (all $ps > 0.05$).

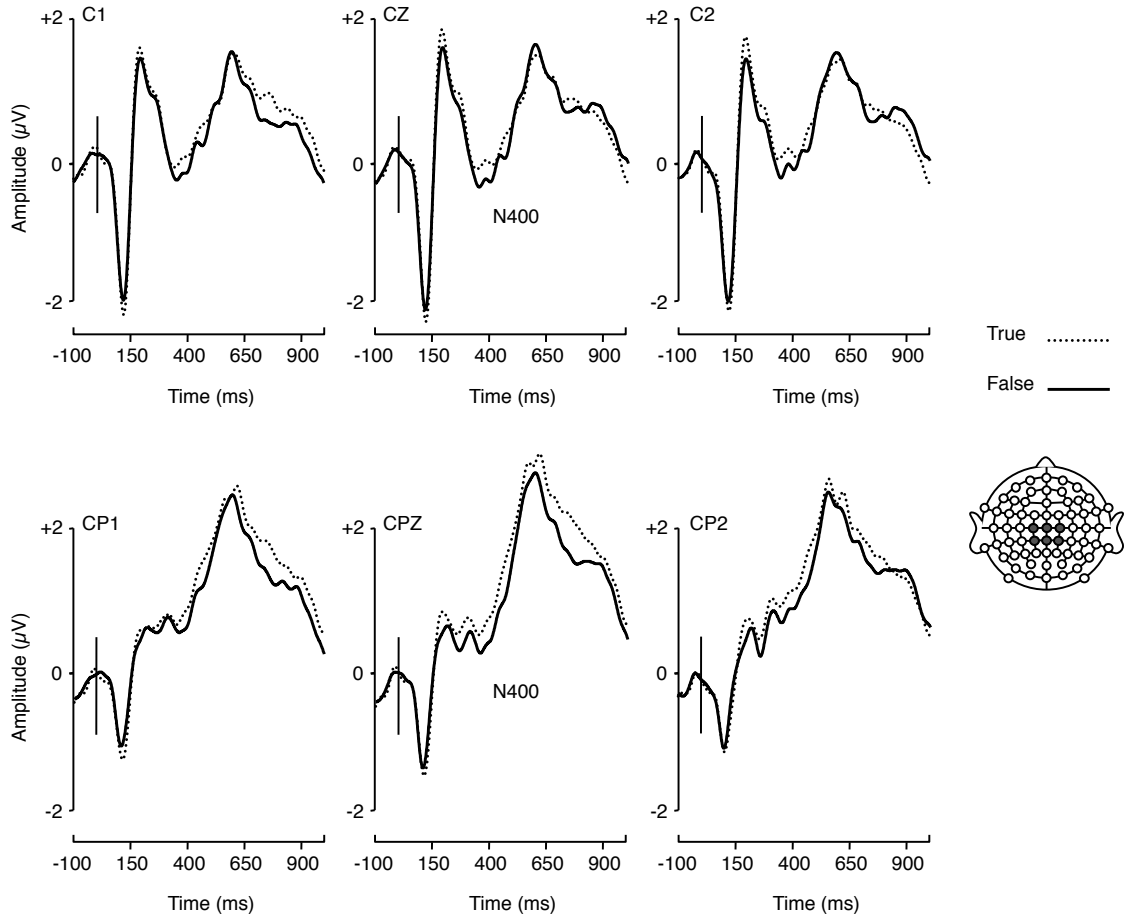


**Figure 3** ERP responses to true and false statements, collapsed across Language and Valence. Waveforms depict averaged brain potentials at the six electrodes included in the N400 analysis (C1, Cz, C2, CP1, CP2, CPz).

We then analysed N400 mean amplitudes for correct responses only ($M$ = 25 trials per condition, $SD$ = 4.58; **Fig. 4**). We found no main effect of Language, Valence, or Truth. However a Language*Truth interaction emerged ($F_{(1,15)}$ = 5.05, $p$ = 0.040). Post hoc analysis split by Language revealed a significant difference between true and false statements presented in English ($F_{(1,15)}$ = 7.87, $p$ = 0.013), but no differences emerged for statements presented in Welsh. No other significant interactions were found (all $ps$ > 0.05).

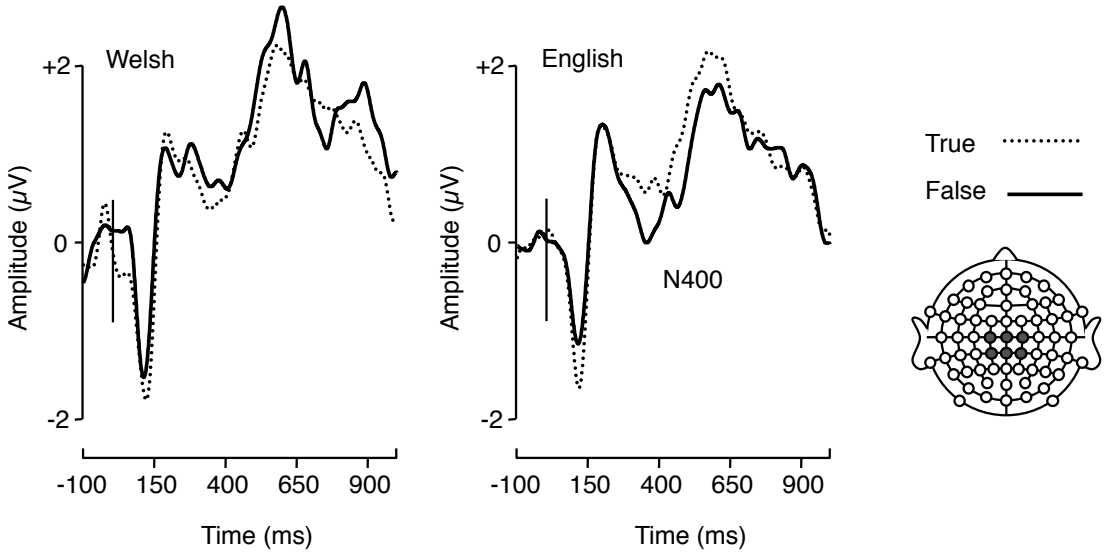


**Figure 4** ERPs elicited by true and false statement completions presented in the native (Welsh) and second (English) language for correct responses only. Waveforms depict average brain potential variations over the 6 electrodes where N400 amplitude was maximal (C1, Cz, C2, CP1, CP2, CPz).

## 4.4 Discussion

In this study, we examined whether perception of culturally relevant statements is modulated by language in early Welsh-English bilinguals. We found that positive statements were accurately categorised when they were true, and much less so when

they were false, an expected bias presumably indicative of 'Welsh pride', which was not affected by the language in which the statements were presented. Conversely, participants displayed the expected reverse bias when dealing with negative statements (i.e., they tended to categorise true statements as false), perhaps to minimise the impact of negative facts, but this bias was only observed in the second language English. Thus, whereas the second language appears to shield the bilingual from detrimental information regarding her culture, the native language does not.

Despite these behavioural differences, participants were overall able to distinguish true from false statements from a semantic integration point of view, as evidenced by the main effect of Truth on N400 mean amplitude (Hagoort et al., 2004; Martin et al., 2013; Ellis et al., 2015). The N400 is known to reflect the extent to which a target word fits within its preceding semantic context, such that greater mean amplitudes index a greater semantic integration effort (Kutas and Hillyard, 1980, 1984). The weakness of the N400 modulation observed here is unsurprising given that Cloze probability was relatively low ($M$ = 52%) by design, such that no strong expectations could be formed by the reader regarding sentence completions (Martin et al., 2013; Kutas & Federmeier, 2011), because the focus was on truth-value rather than semantic expectancy.

However, in the case of trials that yielded a correct response, that is, in those trials in which the contrast between true and false statements was clearly visible in participants' responses, the N400 was modulated by Truth only in English. This

suggests that a second language context favours rational processing as compared to the native language, in which participants display more semantic uncertainty.

Previous studies have suggested that emotions are more strongly linked with L1 than L2 in bilinguals (Altarriba, 2008; Dewaele, 2004; Pavlenko, 2008). Emotion words are arguably comparatively better visualised and contextualised than neutral words in L1 (Altarriba & Bauer, 2004), and are also better recalled in L1 than L2 (Aycicegi & Harris, 2004). Recent findings moreover show that such asymmetric language-emotion links affect cognition more generally in bilinguals. For instance, using event-related brain potentials, Wu and Thierry (2012) showed that Chinese-English bilinguals unconsciously access the native Chinese translations of positive and neutral words presented in English, but not that of negative words. Keysar et al. (2012) and Costa et al. (2014) further showed a reduction of the 'framing effect' in L2: Bilingual participants faced with making a decision (e.g., a forced-choice between two medical treatments) are more sensitive to the positive ('*you can save the lives of 200,000 people*') or negative ('*400,000 people will die*') framing of the situation when presented with the information in L1. A more normative behaviour in L2 suggests more rational evaluation, owing to weaker links between L2 and emotion.

In order to further understand the effects found, and relate behavioural and ERP data more directly, we defined two descriptive indices: (a) a 'pride index' measuring the bias towards accepting positive information; and (b), a 'defence index', measuring the bias towards rejecting negative information, regardless of truth-value (**Fig. 5**). We further tested potential correlations between differences in N400 mean

amplitude and the behavioural indices above with Language by calculating difference waves between false and true conditions for trials that elicited a correct response only (**Fig. 5b**).

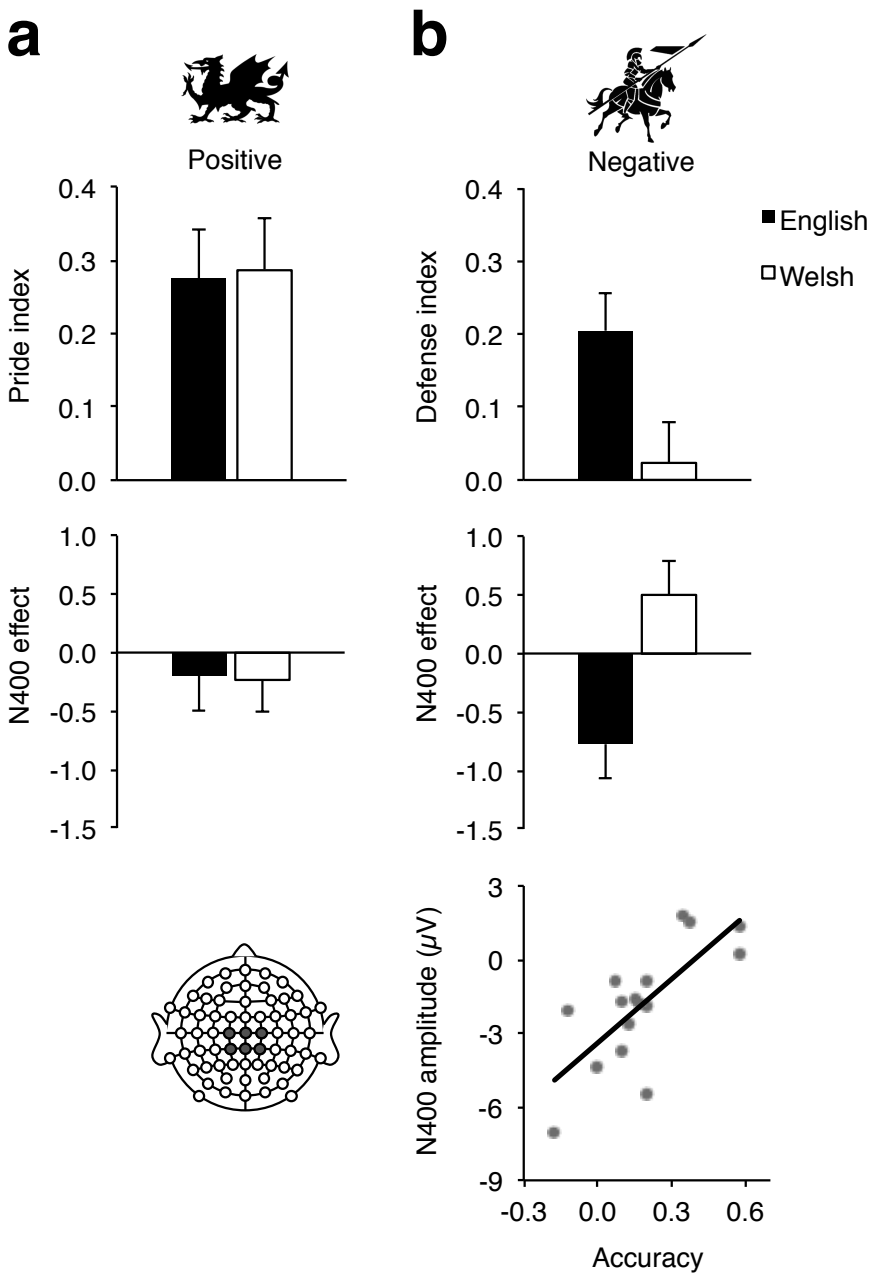


**Figure 5** Relationship between "Pride" and "Defence" index on the one hand and N400 mean amplitude modulations by Truth on the other. **(a)** Positive statements. Top, Difference in accuracy between true and false conditions, i.e., the "Pride index". Bottom, N400 mean amplitude difference between false and true conditions. **(b)** Negative statements. Top, Difference in accuracy between false and true conditions, i.e., the "Defence Index". Centre, N400 mean amplitude difference between false and true conditions. Bottom**,** Correlation

between the difference in the magnitude of the defence index across languages and corresponding mean N400 amplitudes ($r$ = 0.74, $p$ = 0.001, two-tailed). No such correlation was found for the pride index ($r$ = -0.32, $p$ = 0.222, two-tailed).

The significant correlation between mean N400 amplitude and defence index further supports the idea that bilinguals processing detrimental cultural references in their second language show clearer semantic processing contrast between true and false statements, and are more likely to deny undermining comments regarding their culture. In contrast, when participants are faced with such information in their native language, negative statements confuse the semantic system to a greater extent, blurring the contrast between true and false information. However, in order to fully test the robustness of these results, further studies could establish if this results is exclusive to the culture-congruent condition, or if the same pattern of results could be established in the context of the L2.

The mechanism underlying such language-culture dissociation effects must involve interactions between brain structures involved in language-selection networks (e.g., Abutalebi & Green, 2007; Luk et al., 2012), basic emotion generation (e.g., limbic areas, Damasio et al., 2000; Dalgleish, 2004) and regions of the brain implementing higher-order semantic processing (e.g., temporal poles, Lambon-Ralph, Pobric, & Jefferies, 2009; Bonner & Price, 2013). Further research using functional neuroimaging will be required to characterise the neural organisation of such networks.

To conclude, we set out to examine how bilinguals might better defend their cultural values in the native than the second language, but unexpectedly found that

semantic evaluation of negative content is selectively disturbed in the native language. Thus, bilinguals are more susceptible to emotional interference in their native language, but better able to withstand cultural criticism in their second. These results extend language contextual effects beyond the realm of decision-making to the domain of objective information assessment.

# Chapter 5

## Native language, or first language?

## Defining the effect of language on cultural semantics

## Abstract

Recent research has shown that bilinguals perceive and react to culturally relevant information in a language-dependent fashion. When faced with cultural criticism, bilinguals appear to be more sensitive in their native than in their second language, causing them to defend themselves less efficiently. Here, we examine these effects in bilinguals for whom the language pertaining to the native culture is the *second* language. Balanced English-Welsh bilinguals were asked to categorise statements concerning the native Welsh culture as true or false. Whilst participants categorised positive statements as false when they were false, they were biased towards categorising them as false, even when they were true. They showed the reverse bias when categorising negative statements, showing a tendency to consider negative statements as true when they were true, *and* when they were false. Our findings show the opposite bias to that demonstrated in our previous study with Welsh-English bilinguals, with the exception that categorisation behaviour was not modulated by language. When language-culture alignment concerned the second language, bilinguals were inclined to frame the native culture negatively in both languages, suggesting that neither language affords a privileged, emotionally driven link to the native culture.

## 5.1 Introduction

The relationship between language and culture is a vital consideration in an increasingly globalised world. Recent findings show that language not only promotes in-group biases towards the native culture (Danziger & Ward, 2010; Ogunnaike et al., 2010), it can also modulate online semantic access to real world knowledge concerning the native culture (Ellis et al., 2015). This relationship is moreover influenced by whether bilinguals are processing positive statements, indicating cultural pride, or negative statements, indicating cultural criticism (Ellis, Thierry, Vaughan-Evans, & Jones, under review). However, research to date has exclusively examined the relationship between the native culture and the native language when it is also the bilingual's *first*[3], most dominant language. Here, we examine how the relationship changes when the native culture is seen through the lens of the native language, when it is the bilingual's *second* language.

In bilingual communities, it is often the case that one of the languages represents the indigenous, or earlier language, which is closely connected to the culture and traditions of the region; the other represents the language of settlers from an often economically stronger neighbouring region with a larger population of speakers. This is the case in the Basque Country, an autonomous community in northern Spain where approximately 91% of the population is made up of Spanish citizens (Cenoz & Gorter, 2006). The percentage of Basque-Spanish bilinguals in the

[3] Up to this point in the thesis, we have used the term 'native language' both to refer to the language that connects to the native culture and the bilingual's first, most dominant language. In this chapter, we dissociate the two: 'Native language' here refers to the language connecting to the culture (e.g., the Welsh language to the Welsh culture), whilst 'first language' refers to the bilingual's earliest acquired, and dominant language.

Basque Country is said to be 22%, with an additional 14.5% who also have some comprehension and production skills (Cenoz & Gorter, 2006). Friesland, a province of the Netherlands, has experienced a decline in the number of people who can fluently communicate in Frisian, partly due to the increase in younger generations using Dutch as their first language as this is predominantly used in school settings, the media, and the law (Gorter et al., 2001). This is also the case in Wales, in which an estimated 19% of the population can converse in Welsh, however the number of those who can speak, read and write in Welsh is now less at 14.6% (Office for National Statistics, 2011). Thus, although bilingual speakers often identify with the native culture – for example, 66% of people living in Wales identify culturally as 'Welsh' (Office for National Statistics, 2011) – the Welsh language may take on the status of first or second language. Indeed, the ability to speak Welsh at all is considered a marker of increased cultural – Welsh – identity (Williams, 2009), and children as young as four years old are able to identify with their own cultural group (Nesdale, 2004). However, affinity with the native culture in these communities is often coupled with defensiveness against the threat of the out-group, characterised by the non-native culture and its associated non-native language (English, following on from our current example; Giles, Taylor, & Bourhis, 1977; Cloke, Goodwin, & Milbourne, 1998; Fitz, 2000). In Wales, a defensive hostility towards 'British' culture occurs as early as eleven years old, typically upon entering secondary school (Hendry, Mayer, & Kloep, 2007).

How do these cultural forces, associated with personhood and identity interact with language to affect cognition and behaviour? Recent research has shown that

bilinguals can more easily access information concerning the native culture when they are operating in their native language; that is, the language with the strongest association to that culture. For example, Ellis et al. (2015) demonstrated that Welsh-English bilinguals' N400 amplitudes were reduced when processing true statements concerning Welsh culture in the Welsh language. In contrast, the N400 wave was statistically identical in all other cases (processing cultural statements in English, or non-cultural statements in Welsh or English). Ellis et al. (under review) also showed that when judging statements concerning Wales, which contain positive (prideful) or negative (critical) information concerning that culture, bilinguals showed interesting dissociations in the first and second language: Bilinguals were more likely to categorise positive statements as true when they were true, and as true when they were false, demonstrating a 'prideful' bias in favour of the native culture, irrespective of language. However, whilst they showed the anticipated reverse bias for negative statements in English – categorising false statements as false, but also true statements as false – they were surprisingly unbiased in the native language. Ellis et al. identified the source of this behaviour as originating in online semantic evaluation of the statements, reflected in modulation of the N400 wave. Thus, when faced with detrimental reference to their native culture, bilinguals appeared to be more disconcerted in their native language, which caused them to defend themselves less efficiently. These results are attributed to stronger emotional ties to the first language (Dewaele, 2004; Altarriba, 2008; Pavlenko, 2008), and more systematic and rational thinking in the second language (Keysar,

Hayakawa, & An, 2012; Costa et al., 2014; Gao, Zika, Rogers, & Thierry, 2015), enabling a better defence against cultural attack.

In the current study, we wanted to discover how the relationship between the native language and the native culture changes when the status of the native language shifts from being the first, most dominant language for the bilingual, to the second, less dominant language. Thus, we seek to examine how the native culture is perceived when the bilingual's stronger language is incongruent with cultural identity. We therefore asked fluent, English-Welsh bilingual adults – who had been born in Wales – to categorise statements concerning Welsh culture as true or false. These statements were presented in English and in Welsh, in an identical paradigm to that used in Ellis et al. (under review; Chapter 4). We predicted that if vulnerability to criticism of the native culture is a particular feature of the *native* language – regardless of its status as the bilingual's first language (L1) or second language (L2) – then we would find a similar pattern of results to that found in our previous study (Ellis et al., under review). However, if vulnerability to criticism of the native culture is a feature of the *first* language, then we should find the opposite pattern of results to that found in our previous study. That is, English-Welsh bilinguals will show more defensive behaviour in their L2 Welsh, compared with their L1 English. Finally, if the incongruence between the L1 (English) and the cultural group (Welsh) leads to a different perspective on the native culture, we expect categorisation behaviour that is less 'pro Welsh' than observed previously. For example, we may anticipate a reduced bias compared with our previous study.

## 5.2 Method

### 5.2.1 Participants

Eighteen English-Welsh bilinguals (13 females; $M_{age}$ = 23.44, *SD* = 4.98) were tested, all of which had normal or corrected vision, were right-handed, and reported no language impairments. Participants self-reported their language status and proficiency, indicating that they had been exposed to their L1, English, since birth, and that they had acquired their L2, Welsh, at an early age (*M* = 4.47, *SD* = 2.84). Participants' ratings of language proficiency (on a scale of 1 = not literate, to 10 = very literate) for reading, writing, speaking and comprehension were high for English (*Grand M* = 9.68, *SD* = 0.70), and Welsh (*Grand M* = 8.39, *SD* = 1.26). Participants reported more daily use of English (*M* = 66.39%, *SD* = 11.48) compared with Welsh (*M* = 33.61%, *SD* = 11.48). The Multigroup Ethnic Identity Measure (MEIM; Phinney, 1992) was used to ascertain the strength of participants' cultural belonging (1 = indifferent cultural response to 4 = strong cultural response). All participants identified their culture to be Welsh or Welsh-British/British. Those who stated Welsh as their culture (n = 9) displayed a stronger affiliation to that culture (*M* = 3.13, *SD* = 0.32) than those who stated Welsh-British/British as their culture (n = 9; *M* = 2.61, *SD* = 0.54; $t(16) = 2.48$, $p = 0.025$), suggesting that the latter group indicated a lower affinity with their chosen group. Participants provided informed consent and took part in the experiment in return for payment. Ethical approval was granted by the School of Psychology ethics committee at Bangor University.

### 5.2.2 Stimuli and procedure

Stimuli were identical to those implemented and validated in Ellis et al. (under review). Three hundred and twenty statements in English and their Welsh translations were presented. Within each language, the statements were divided into 40 sets of 8, which ended in the same final word. Participants viewed four statements from the English sets, and four statements from the Welsh sets that were not the translation of the English selection (see Table 1). Thus, for any given participant, experimental sentences were never repeated, not even by way of translation. Therefore, the experimental design involved three factors: Language (English, Welsh), Valence (positive, negative), and Truth-value (true, false). Valence and Truth-value were counterbalanced across languages.

**Table 1** Experimental design and example of a statement 'set'

| **Set a** | Truth | Valence |
|---|---|---|
| 'The land of my fathers' is the oldest and most and respected ***anthem.*** | False | Positive |
| Before a rugby match, our players proudly sing the ***anthem.*** | True | |
| Some of our assembly members are fighting to get rid of the ***anthem.*** | False | Negative |
| Some people want an English version of our ***anthem.*** | True | |

| **Set b** | Truth | Valence |
|---|---|---|
| Every person in Wales loves to sing the ***anthem.*** | False | Positive |
| It is truly patriotic to know the words to our ***anthem.*** | True | |
| None of our rugby team players know the words to the ***anthem.*** | False | Negative |
| It is difficult to sing along in tune to our ***anthem.*** | True | |

Stimuli were presented in centre-screen position of a 19-inch CRT monitor with a refresh rate of 75 Hz, in white, courier new, 18-point font on a black background. Presentation of the first clause of each statement was self-paced, followed by single-word presentation of the final clause of each statement at a rate of 200 ms per word and an inter-stimulus interval of 500 ms. This method enabled us to obtain an accurate measure of reaction time in response to the critical word-final item in each statement. The order of presentation was pseudorandomised, such that participants would not encounter the same final word within a single block. Following each statement, participants made a true/false judgement by implementing a binary button press response.

## 5.3 Results

Accuracy and reaction times were modelled as a function of three within-subject fixed factors: Language (Welsh, English), Valence (positive, negative), and Truth-value (true, false). For accuracy data, a binomial logistic regression was implemented. Reaction time data were log transformed and examined with linear mixed effects analyses. All analyses were conducted using R (R Development Core Team, 2008) using the lme4 library (Bates, Maechler, & Dai, 2008; Baayen, 2008). $\beta$-values are reported, and tested at $p < 0.05$.[4]

[4] In an additional analysis, we included MEIM (explicit cultural identity) scores into the model as a fourth, categorical factor ($n = 9$ participants identified as Welsh; $n = 9$ participants identified as Welsh-British/British). ANOVA revealed that including MEIM scores in the model did not significantly alter the fit of the primary model, $X^2 = 2.58$, $df = 11$, $p = 0.108$. Thus, the model reported does not include this variable.

For accuracy data (**Fig. 1**), the maximal interaction model was found to provide the best fit for the data, compared with lower-order interaction models, $X^2$ = 187.58, $df$ = 10, $p < .0001$ (Barr et al., 2013). Stimulus items and participants were included as random effect variables and were modelled as a function of intercept performance. A maximal by-participant random slope was initially included, but was removed owing to non-convergence in the model. Thus, the formal specification of our model was:

```
glmer(Accuracy ~ Language*Truth*Valence + (1|Participant) + (1|Item), data = [dataframe], family = binomial)
```

The intercept represents the average likelihood that participants were accurate in the English/Positive/False condition. Each coefficient compares the average for a different combination of fixed factor levels against this intercept.

Participants displayed a bias for positive statements, such that false statements were categorised more accurately than true statements ($b$ = -1.02, $z$ = 8.67, $p < 0.0001$). The opposite bias emerged for negative statements, such that true statements were more likely to be categorised correctly ($b$ = 1.56, $z$ = 9.42, $p < 0.0001$), but false statements were more likely to be categorised incorrectly, compared to baseline ($b$ = -0.87, $z$ = -7.53, $p < 0.0001$).

Crucially, there were no differences between languages in all conditions (Postive/True: $b$ = -0.03, $z$ = -0.17, $p$ = 0.867; Positive/False: $b$ = 0.11, $z$ = 1.05, $p$ = 0.292; Negative/True: $b$ = 0.04, $z$ = 0.19, $p$ = 0.852; Negative/False, $b$ = -0.03, $z$ = -0.20, $p$ = 0.845).

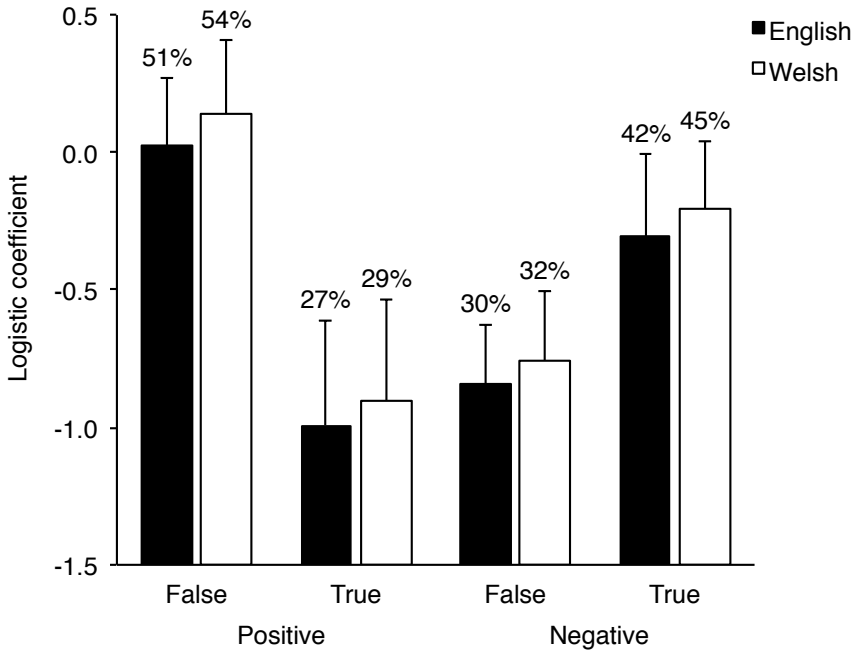


**Figure 1** Accuracy scores (% provided above each bar) for truth judgements as a function of Language, Truth, and Valence. Error bars represent SEs.

For RT data (**Fig. 2**), a lower-order interaction model was found to provide the best fit for the data as compared to the additive model, $X^2 = 34.28$, $df = 22$, $p < .0001$ (Barr et al., 2013). Stimulus items were modelled as a function of intercept performance, whilst participants were modelled as a function of the intercept plus a slope for the lower-order interaction of conditions. The maximal by-participant random slope caused non-convergence of the model. Thus, the formal specification of our model was:

lmer(log(RT) ~ Language+Truth*Valence + (1+ Language+Truth*Valence|Participant) + (1|Item), data = [dataframe], family = binomial)

The intercept again represents the average likelihood that participants were accurate in the English/Positive/False condition. Each coefficient compares the average for a different combination of fixed factor levels against this intercept.

For the positive condition, participants were faster at responding to true as compared to false statements ($b$ = -0.15, $t$ = -3.09, $p$ = 0.002), and response times did not differ between languages ($b$ = 0.02, $t$ = 0.32, $p$ = 0.746). RTs to both false and true statements differed between positive and negative statements, such that for the negative condition, false statements were categorised marginally more slowly ($b$ = -0.10, $t$ = -1.94, $p$ = 0.052), whereas true statements were categorised more quickly ($b$ = 0.24, $t$ = 3.75, $p$ < 0.001).

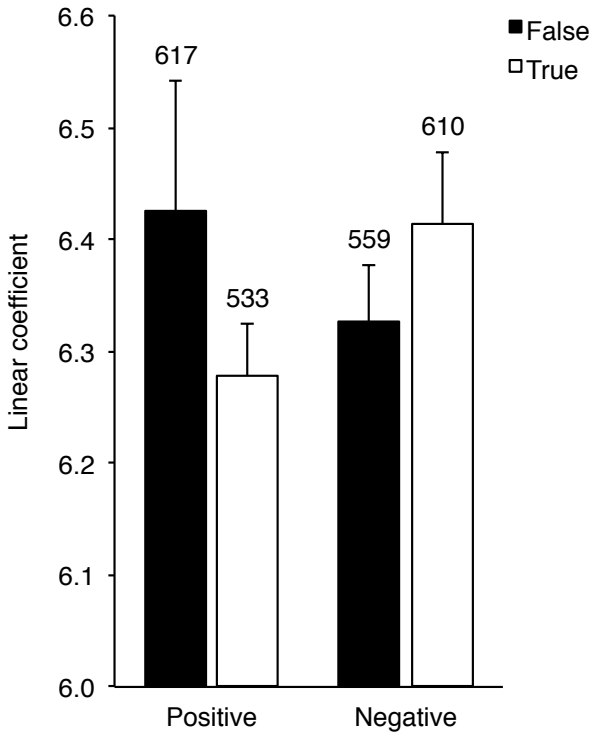


**Figure 2** Reaction Times (average provided above each bar) for truth judgments as a function of Truth and Valence. Error bars represent SEs.

As in our previous work, we examined the existence of a speed-accuracy trade-off by correlating accuracy with RTs (as per Ellis et al., 2015). Despite the apparent trends in Figures 1 and 2, no evidence of a speed-accuracy trade-off emerged (all $p$s > 0.08).

## 5.4 Discussion

We examined whether judgement of culturally relevant statements is modulated by language in early English-Welsh bilinguals. We sought to ascertain whether the particular connection between the native language and the native culture, observed previously, endures even when the native language is the bilingual's second language. Our results revealed that in categorising statements, English-Welsh bilinguals showed a bias *against* the Welsh culture: Participants were more likely to categorise positive statements as false when they were false, but they were also more likely to categorise these statements as false, even when they true. Conversely, they were more likely to categorise negative statements as true when they were true, but they were also more likely to categorise these statements as true, even when they were false. Moreover, these bilinguals displayed a similar degree of bias in both of their languages.

Previous findings indicated that Welsh-English bilinguals demonstrate an overall positive bias towards the native Welsh culture, and when faced with cultural criticism, are less able to defend their culture in the native (and first) language, compared with the second language (Ellis et al., under review). Here, we show that English-Welsh bilinguals show the *opposite* bias, displaying an overall negative bias towards the native Welsh culture, and no evidence of language dissociation when faced with cultural attack.

From the current findings, we make several inferences with respect to the relationship between language and cultural identity: We found no evidence of a privileged link between the native language and the native culture in English-Welsh

bilinguals as compared to our previous findings (Ellis et al., under review), but our data also indicated no evidence to suggest that the *first* language formed a privileged link with the native culture either (in which case we could have expected evidence of cultural defensiveness in Welsh, the second language, compared with English, the first language). With respect to our previous study (Ellis et al., under review), our current data suggest that the privileged language-cultural link *only* occurs when there is congruency between the bilingual's L1 and the native culture (i.e., dominance in the Welsh language linking with Welsh cultural identity). Incongruence between the bilingual's L1 and cultural identity, as in the current experiment, effectively breaks the particular language-cultural link. Thus, these bilinguals are biased with respect to the native culture, and their negative biases suggest that their views reflect those most often associated with opinions espoused in the L1, non-native language. However, it remains the case that both of their languages act in unison.

Previous research has suggested closer connections between the L1 and emotional processing, compared with the L2 (Dewaele, 2004, 2008; Harris, Aycicegi, & Gleason, 2003; Harris, 2004; Pavlenko, 2012), leading to recent suggestions from our lab and others that bilinguals are therefore more rational and analytical in their second language (Costa et al., 2014; Keysar, Hayakawa, & An, 2012; Gao et al., 2015), and more vulnerable to criticism in their first language (Ellis et al., under review). In relation to the particular connection between the native/first language and higher level, semantic processing associated with personhood – in this case, cultural identity – our findings suggest that the link is highly specific. Thus, for bilinguals whose first

language is impermeably linked with native culture, particular associations and episodic memories formed between the native L1 and cultural information – often with strong emotional connotations – allow the L1 to dissociate from the L2 when processing information pertaining to the native culture (Marian & Neisser, 2000; Marian & Kaushanskaya, 2004; Schrauf, Pavlenko, & Dewaele, 2003). However, for the current sample of bilinguals, we suggest that similar associations, facts and memories that form concerning the native culture are allotted a less emotionally salient role, because the native language (Welsh) has second language status, and the first language (English) is incongruent with the native culture.

However, our theoretical conclusion should also be viewed in the context of participants' indication of cultural identity. In the ideal scenario, all of our current L1 English bilinguals would have indicated 'Welsh' as their cultural identity, and that the strength of this association would have corresponded with the L1 Welsh bilinguals tested previously. This would have allowed a more definitive test of language status per se. However, realistically, the L1 English bilinguals' language status is likely to go hand in hand with less affinity with the native culture, which is generally what we see here: Whereas participants' overall scores on the MEIM was indicative of Welsh or closely affiliated Welsh-British/British cultural identification, we note that their scores were on average lower than those of our native bilingual group in Ellis et al. (under review). Statistical analysis revealed that MEIM score did not alter the language-culture behaviour observed in the experiment, but we accept that it could in part contribute to the overall negative or hostile bias demonstrated by these bilinguals in

response to their 'native' culture, and the overall lower accuracy scores, compared with those seen previously in Ellis et al (under review). That is, these participants may simply have known less factual information concerning the native culture compared with their native-language speaking peers.

To conclude, we set out to examine how language interacts with cultural identity for bilinguals for whom information concerning the native culture has been primarily processed in the non-native language. Contra previous findings with native-L1 bilinguals, our current results showed no evidence of dissociation between the L1 and L2, suggesting that the privileged connection between language and culture in bilinguals depends on the native language also being the first, most dominant language.

# Chapter 6

## Mood and language interact to affect implicit cultural biases[5]

[5] This paper is to be submitted to *Psychological Science* as:
Ellis, C., Hadden, L. M., & Jones, M. W. Mood and language interact to affect implicit cultural biases.

## Abstract

Language has been shown to selectively influence access to culturally relevant associations in bilinguals. However, findings thus far assume that interactions between language and culture are fixed, attributable to a lifetime of association between the two. Here, we investigated the effect of transient mood states on the relationship between language and culture. Specifically, we examined how the induction of positive, negative or neutral moods in Welsh-English bilinguals resulted in varying degrees of cultural bias, measured via the Implicit Association Test (IAT). Bilinguals showed an overall stronger implicit cultural bias when the IAT was in Welsh compared to when it was in English. Crucially, mood affected cultural bias differently, depending on whether these bilinguals were functioning in Welsh or in English. In the second language, English, both positive and negative moods produced greater cultural bias compared with the baseline, neutral condition. However, in the native Welsh language, baseline cultural bias was already set at a higher level than in English, and mood manipulation had comparatively little effect. Our findings suggest that the native language promotes bias towards the native culture, which is relatively fixed. Bilinguals' second language is relatively unbiased, but can be provoked into bias by the elicitation of transient emotions.

## 6.1 Introduction

Language has recently been shown to affect how we predict (Casasanto & Lupyan, 2015), perceive (Lupyan & Clark, 2015), process and judge information that pertains to our native and non-native culture (Briley, Morris, & Simonson, 2005; Danziger & Ward, 2010; Ogunnaike, Dunham, & Banaji, 2010; Ellis et al., 2015), with recent data suggesting that bilinguals' second language can even filter unpleasant information concerning the native culture (Ellis, Thierry, Vaughan-Evans, & Jones, under review). Here, we extend this investigation to examine whether language also interacts with *transient* emotional states to affect perception of the native culture.

A substantial body of literature attests to the influence of incidental emotions on social cognition, which not only affects our conscious expression of beliefs about others (for a review see Bodenhausen et al., 2001); it also influences implicit, automatic biases in our attitudes to social groups (e.g. DeSteno, Dasgupta, Bartlett, & Cajdric, 2004). Specifically, a number of studies now show that mood states[6] arising from external sources unrelated to culture or stereotypical groups influence how we automatically judge and stereotype others. For example, emotions such as anger, which signals a need for quick action, and happiness, which indicates satisfaction, induce a heuristic style of cognitive processing, which promotes greater reliance on stereotypes (DeSteno et al., 2004; Cottrell & Neuberg, 2005; Bodenhausen et al., 1994a, 1994b; Tiedens & Linton, 2001). In contrast, other moods such as sadness signals the need for caution and indications of personal loss, thus resulting in a more systematic,

[6] For clarity, we refer to 'mood' as an incidental, transient emotional response to an environmental stimulus (see Cox, 2002; Damasio, 1994; Keltner & Gross, 1999; Stirling and Kerr, 2006).

analytic style of processing that results in a decreased reliance on stereotypes (Lambert, Khan, Lickel, & Fricke, 1997; DeSteno et al., 2010; Park & Banaji, 2000).

What mechanism, then, drives the relationship between mood states and social evaluations of this kind? Recent theorising suggests that in evolutionary terms, specific emotions act as a context-sensitive signalling cue, in which certain environmental conditions trigger fast, automatic processing responses that supersede slower, more analytical cognitive styles. This approach is highly adaptive, proving efficient when the environment is optimal (e.g., happy emotions), and a means of defence when there is a threat of danger (e.g., fear emotions; see van Kleef & Fischer, 2016 for a review). Moreover, this cue often leads to increased autonomic arousal (see Clark & Fiske, 2014 for a review), which facilitates the system that governs an individual's motivational 'approach or avoid' reactions (Bradley & Lang, 1994; Lang & Bradley, 2010). At the neural level, overlapping networks have evolved for social evaluation (Phelps et al., 2000; Goldin et al., 2008; Ochsner et al., 2000; Damasio et al., 2000) and regions involved in the experience of emotions (Adolphs, 2003; Rothbart, 2007; LeDoux, 2012), further suggesting an inextricable link – leading to emotion-driven biases (Cottrell & Neuberg, 2005; Fiske et al., 2002).

However, emotional state is but one factor found to influence social group biases. A hitherto separate, and considerably smaller field of research has also examined the influence of *language* on social group bias, which show that when language and culture align, there is a stronger bias towards the in-group. For example, Ogunnaike, Dunham, and Banaji (2010) used the implicit association test (IAT) to

measure implicit social group biases. The IAT is a widely used measure of implicit attitudes, which are measured based on the premise that it is easier to categorise related concepts than it is to categorise relatively unrelated concepts, therefore faster and more accurate responses to related concepts signal an automatic bias. Ogunnaike et al. (2010) found that French-Arabic bilingual Moroccans showed greater pro-Morocco attitudes when assessed in Arabic as opposed to French. Similarly, Spanish-English bilinguals showed pro-Spanish bias when categorising Spanish and English names. These results are likely to reflect recollection of pertinent cultural memories in the native language (Marian & Kaushanskaya, 2004; Marian & Neisser, 2000; Schrauf, Pavlenko, & Dewaele, 2003), or prime associations and norms characteristic of speakers of the language (Briley, Morris, & Simonson, 2005; see also Danziger & Ward, 2010).

Thus far, we have reviewed the evidence for *separate* effects of language and emotional states on cultural bias, but recent data indicates that emotions processing can also modulate the effect of language on cultural perceptions and judgement (Ellis et al., under review). However, the emotional valence of the statements presented in this study was immutable, learned over a lifetime of immersion in the native culture (e.g., "*A deeply Welsh and noble way of life is represented by our farmers*"). Here, we examined whether language also interacts with emotional states that are *not* directly elicited by the cultural statement itself; instead, the emotional state comprises a mood, elicited by generic stimuli, wholly unrelated to the native culture, as per manipulations

in the social cognition literature reviewed above (e.g. DeSteno et al., 2004, Park & Banaji, 2000; Bodenhausen et al., 1994a).

Welsh-English bilinguals' automatic cultural biases were measured using the Implicit Association Test (IAT; Greenwald et al., 1998), which has been shown to be a valid and reliable measure of implicit attitudes and biases (Nosek, Greenwald, & Banaji, 2007; Greenwald, Poehlman, Uhlmann, & Banaji, 2009; Castelli, Zogmaister, & Tomelleri, 2009; Plant et al., 2009), including cultural biases (Danziger & Ward, 2010; Ogunnaike, Dunham, & Banaji, 2010). Prior to presentation of the IAT, we manipulated participants' moods, in conditions that elicited a positive mood ('Happiness'), a neutral mood, or a negative mood ('Sadness'). Happiness and sadness were chosen as opposing moods on the spectrum of positive and negatively valenced emotions, owing to their removal from the more socially driven mood states represented in pride or anger (e.g., DeSteno et al., 2004; Park & Banaji, 2000). Our aim was to conduct a conservative examination of the effect of mood on cultural bias, in the absence of any social signals in the elicitation of the mood state. Given previous findings, we expected stronger overall implicit cultural bias when participants completed the cultural-attitude IAT when it was presented in the native language, Welsh, compared to when it was presented in English (Ogunnaike et al., 2010; Danziger & Ward, 2010). We moreover expected that positive mood induction would exert maximal cultural bias effects in both languages, but that the bias would be relatively stronger in the native language, given stronger ties between emotions processing and the native language (Dewaele, 2004; 2010; Pavlenko, 2008). We also

expected that negative mood induction would exert minimal cultural bias effects in both languages, but this would be most pronounced in the second language.

## 6.2 Method

### 6.2.1 Participants

Forty-one participants were recruited for the study. Data from twelve participants were excluded; nine reported English as their first language, two were excluded on the basis of the IAT scoring procedure recommended by Greenwald, Nosek, and Banaji (2003), and one participant did not complete the study. A total of twenty-nine highly proficient Welsh-English bilinguals (all female; $M_{age}$ = 20.41, *SD* = 2.31) were therefore included in the final analysis. All participants had been exposed to the Welsh language from birth, and had acquired English at an early age (*M* = 3.83, *SD* = 2.21). Participants' self-reported language proficiency (on a scale of 1 = not literate, to 10 = very literate) for reading, writing, speaking and comprehension were high for both Welsh (*Grand M* = 9.03, *SD* = 1.44), and English (*Grand M* = 8.54, *SD* = 1.46). Participants reported more daily use of Welsh (*M* = 67.69%, *SD* = 17.67%) than English (*M* = 35.41%, *SD* = 16.67%).

The Multi-group Ethnic Identity Measure (MEIM; Phinney, 1992; Roberts et al., 1999) was used to measure explicit cultural identity, and was presented in either Welsh or English depending on the language of the testing session (scores range from 1 = disagreement with cultural statement to 4 = strong agreement with cultural statement). There were no differences between the scores of those who completed the

questionnaire in either Welsh or in English; $t(27) = -0.32$, $p = .748$. All participants stated that their cultural group was Welsh. The two subscales of the measure revealed that participants made an effort to understand their culture ('Identity Search'; $M = 2.98$, $SD = 0.54$, $\alpha = .69$), and indicated that they had a strong sense of cultural pride ('Affiliation and Belonging'; $M = 3.58$, $SD = 0.31$, $\alpha = .74$).

The School of Psychology ethics committee at Bangor University granted ethical approval and all participants gave informed consent.

### 6.2.2 Stimuli

#### The Implicit Association Test (IAT)

For the present study, two identical versions of the cultural attitude IAT were used (Danziger & Ward, 2010), one in Welsh, and the other in English; each implemented with Inquisit 4.0 Millisecond software. The names and traits used in the Welsh and the English versions of the IAT were matched for word frequency, valence and arousal (see Hadden et al., submitted).

In each of the Welsh-language and English-language IATs, participants categorised Welsh (*Branwen, Cerys, Ieuan, Dafydd, Rhys*) and English names (*Alice, Mary, Henry, John, David*), "good" trait words (Welsh: *da, clyfar, glan, hapus, cryf*; English: *good, smart, clean, happy, strong*), and "bad" trait words (Welsh: *drwg, twp, budr, gwan, blin*; English: *bad, dumb, dirty, weak, angry*), as quickly as possible by pressing keys ('D' or 'K') on a computer board (see **Table 1**). Participants had to correctly categorise each name or trait before continuing to the next trial. In the

current study, a *congruent critical combined block* denotes when we can expect names and traits to be highly associated for this participant group, i.e., Welsh and good, and English and bad; conversely, an *incongruent critical combined trial* represents when names and traits are dissociated, i.e., Welsh and bad, and English and good.

**Table 1** Example of the content used in the Welsh-English language IAT

| | | | Response key | |
|---|---|---|---|---|
| Block | *N* trials | Task | Left key ('D') | Right key ('K') |
| 1 | 20 | Name categorisation | Welsh | English |
| 2 | 20 | Trait categorisation | good | bad |
| 3 | 25 | Congruent critical combined block | Welsh, good | English, bad |
| 4 | 40 | Congruent critical combined block | Welsh, good | English, bad |
| 5 | 30 | Reversed name categorisation | English | Welsh |
| 6 | 25 | Incongruent critical combined block | English, good | Welsh, bad |
| 7 | 40 | Incongruent critical combined block | English, good | Welsh, bad |

**Congruency of critical combined blocks (i.e., blocks 3-4 and 6-7) and language of the IAT were counterbalanced between participants.*

Blocks 1 and 2 are practise blocks for names and traits, respectively. Block 3 is the first 'practise' trial of a critical combined block, and block 4 is the 'test' block for this combination. Block 5 is a practise of the reverse key allocation for names. Blocks 6 and 7 are the 'practise' and 'test' blocks for the remaining critical combination of names and traits.

## Mood manipulation

Emotional film clips were used to elicit mood, which provides a reliable and widely used method of mood manipulation (Rottenberg, Ray, & Gross, 2007; Hewig et al., 2005; Coan & Allen, 2007; Egidi & Nusbaum, 2012). In order that videos could be used in each of the Welsh and English language sessions, the content of each was

completely absent of linguistic cues (dialogue, voiceover, subtitles etc.). Further, for each mood condition, two videos were constructed in order to avoid repetition of materials across the testing sessions. 'Positive' videos were constructed to reflect feelings of happiness, negative videos reflected feelings of sadness, and neutral videos reflected tasks and scenarios generally considered to be devoid of any particular emotion (Gross & Levenson, 1995; Stanton, Reeck, Huettel, & LaBar, 2014; Wang, LaBar, & McCarthy, 2006). Videos were compiled based on a format used by Rottenberg et al., (2007). We used short scenes from popular films and stock videos, coupled with music that was congruent with the mood manipulation (a brief description of each video is provided in **Table 2**).

**Table 2** Summary of videos used in the experiment

| Version | Duration | Music | Content |
|---|---|---|---|
| Positive 1 | 03:26 | "One Day Like This" by Elbow. | A new-born baby smiling; People smiling; People dancing in different contexts; Family enjoying a barbeque; Friends watching a sunset. |
| Positive 2 | 03:29 | "Stars" by Basspartout. | Exercising; Nature; Sunshine; A young couple in love; People reuniting at an airport. |
| Neutral 1 | 03:33 | "Opening" by Andrea Guerra. | Office work; Reading; Microwave countdown; Passengers waiting at a train station platform; Cleaning. |
| Neutral 2 | 03:34 | "Dead Already" by Thomas Newman. | A tube platform; Traffic; A shopping trolley being pushed around a store; Man watching the clock to leave work. |
| Negative 1 | 03:26 | "Cold" by Jorge Mendez. | Children fleeing from war; Homelessness; Domestic violence; Robber committing crime; Failed attempt at escape being watched by woman. |
| Negative 2 | 03:29 | "Funeral For a Tree" by John Powell. | A destroyed city; Cancer patient losing hair; A retired soldier visiting graves of war heroes. |

## Mood manipulation check

Forty monolingual English participants who did not take part in the experiment proper (29 females; $M_{age}$ = 21.28, $SD$ = 6.91) participated in a norming study to confirm that the videos elicited the intended moods. Participants' positive and negative affect scores after watching each video were measured using the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988; presented online on Bristol Online Surveys). Ten emotional items measured each affective state (positive and negative) on a 5-point intensity scale (1 = not at all to 5 = extremely).

In the norming procedure, participants viewed a single video then immediately completed the PANAS and then a filler questionnaire to ensure participants were paying attention to the content of the videos. The order in which videos were viewed was counterbalanced across participants, with neutral mood videos presented between each of the positive and negative videos. A 3 (Mood: positive, neutral, negative) x 2 (PANAS affect score: positive, negative) x 2 (Video version) within-subjects ANOVA revealed a main effect of Mood ($F_{(2, 78)}$ = 21.56, $p$ = .000, $\eta_p^2$ = .356) and PANAS affect score ($F_{(1, 39)}$ = 285.42, $p$ = .000, $\eta_p^2$ = .880), as well as a Mood*PANAS affect score interaction ($F_{(2, 78)}$ = 153.60, $p$ = .000, $\eta_p^2$ = .798). There was no main effect of Video version ($F_{(1, 39)}$ = 3.23, $p$ = .081, $\eta_p^2$ = .076) or any other interaction (Mood*Video version: $F_{(2, 78)}$ = 2.71, $p$ = .073, $\eta_p^2$ = .065; Video version*PANAS affect score: $F_{(1, 39)}$ = 1.35, $p$ = .253, $\eta_p^2$ = .033; Mood*Video version*PANAS affect score: $F_{(2, 78)}$ = 0.15, $p$ = .861, $\eta_p^2$ = .004). In sum, the norming study revealed that each of the videos purporting to elicit a given mood, did so. Mean affect scores for the positive (positive

PANAS: $M = 31.43$, $SD = 7.35$, negative PANAS: $M = 10.30$, $SD = 0.78$), negative (positive PANAS: $M = 18.19$, $SD = 5.13$, negative PANAS: $M = 18.61$, $SD = 4.90$), and neutral (positive PANAS: $M = 22.26$, $SD = 5.12$, negative PANAS: $M = 11.44$, $SD = 2.44$) mood conditions were comparable with previous use of the PANAS (Watson, Clark, & Tellegan, 1988; Crawford & Henry, 2004) and consistent with literature using PANAS as a mood manipulation check (Pretz, Totz, & Kaufman, 2010).

In order that the Welsh and English language sessions remained monolingual, we created a Welsh translation of the PANAS, which was verified by a professional translator. Frequency values obtained from the 'Cronfa Electroneg o Gymraeg' (Welsh; Ellis et al., 2001), and the CELEX lexical database (English; Baayen, Piepenbrock, & Van Rijn, 1993) moreover showed no differences between the Welsh ($M = 51.00$, $SD = 77.92$) and English ($M = 45.55$, $SD = 55.46$) version of the PANAS; $t(19) = 0.49$, $p = .630$. For the valence and arousal scores, twelve Welsh-English bilinguals (10 females; $M_{age} = 29.67$, $SD = 14.44$; all first language Welsh) who did not take part in the experiment proper completed a paper and pencil version of the Self-Assessment Manikin (SAM; Lang, 1980; Bradley & Lang, 1994; 1999), where participants rate their emotional state on a 5-point pictorial scale. The presentation of the Welsh and English language versions of the test were counterbalanced across participants. There were no differences in the overall mean valence scores for the Welsh ($M = 3.00$, $SD = 1.31$) and English ($M = 3.08$, $SD = 1.18$) versions of the PANAS; $t(19) = -0.73$, $p = .472$; nor a difference in the overall mean arousal scores for the Welsh ($M = 3.45$, $SD = 0.48$) and English ($M = 3.56$, $SD = 0.45$) versions; $t(19) = -$

1.55, $p = .139$. Finally, participants were asked to rate on a 4-point scale how well the translation equivalent words corresponded to each other (1 = perfect match to 4 = no match at all); a low mean value indicated that participants deemed the words to be a good match ($M = 1.44$, $SD = 0.58$).

### 6.2.3 Procedure

Testing was conducted individually in two separate 45-minute testing sessions. Each testing session was identical, but one was conducted fully in Welsh and the other fully in English. The order (Welsh/English) was counterbalanced between participants and held a week apart. Within each session, a baseline PANAS was administered via Bristol Online Surveys, which provided an indication of the participant's feelings over the past week. Any participants with abnormally high scores on the NA subscale (raw score of 30), or any abnormally low scores on the PA subscale (raw score of 17) were not deemed suitable for the mood manipulation (for a review of clinical applications of the PANAS see Crawford & Henry, 2004), but no-one reached this exclusion criteria. Participants then viewed the first affective video (positive or negative) before completing the IAT, and then another PANAS was implemented to ascertain change in mood. This sequence was repeated for the neutral and second affective condition (positive or negative). Participants were given a break between each mood condition to complete a language history questionnaire and the MEIM (Phinney, 1992), as well as other filler tasks that consisted of grammar and spelling worksheets. All questionnaires were provided in Welsh or in English depending on the language of

testing session (demographic information was only collected in the first session). In an attempt to reduce demand characteristics, where participants' knowledge of the experimental manipulations may affect the outcome (Martin, 1990; Berkowitz, Jaffee, Jo, & Troccoli, 2000), participants were informed on the purpose of the videos only after completing both experimental sessions in the form of a debrief sheet.

### 6.2.4 Data analysis

Participants' responses to critical blocks in which Welsh and English names were paired with either good or bad trait words were analysed using the improved scoring algorithm recommended by Greenwald, Nosek and Banaji (2003). The 'IAT effect' and subsequent measurement (IAT *D* score) was calculated based on the following steps: (1) Participants were removed if more than 10% of trials had response latencies < 300ms; (2) The "inclusive" standard deviation for response latencies in Blocks 3 and 6 ('practice' critical blocks) and in Blocks 4 and 7 ('test' critical blocks) was computed; (3) Mean response latencies were computed for each critical block (Blocks 3, 4, 6 and 7); (4) Mean differences between the two critical 'practice' and 'test' blocks were computed ($Mean_{Block\ 6} - Mean_{Block\ 3}$, and $Mean_{Block\ 7} - Mean_{Block\ 4}$); (5) The two mean difference scores were then divided by its associated "inclusive" standard deviation; (6) the resulting *D* score was computed from the equal-weight average of these scores. Additionally, response latencies for each participant in each block were trimmed to within 2 standard deviations after step 1 (Danziger & Ward, 2010). Since congruent responses (Blocks 3 and 4; Welsh and good/English and bad; as shown in the example

in Table 1) are subtracted from incongruent responses (Blocks 6 and 7; English and good/Welsh and bad), a larger *D* score in this instance indicates a *more favorable* implicit attitude towards the cultural in-group (Welsh). Calculated in this way, the resulting *D* score also indicates the strength of the effect size, and thus a value of .15, .35, and .60 correspond to small, medium, and large effects, respectively (Rudman, 2011).

### 6.3 Results

Analyses were conducted on 93% of the data, that is, response latencies that did not exceed +/- 2 SD. A within-subjects repeated measures ANOVA was conducted with Language (Welsh, English) and Mood (positive, neutral, negative) as independent variables.

A main effect of Language showed that, when the IAT was administered in Welsh, participants showed a greater overall cultural bias than when it was presented in English ($F_{(1, 28)} = 7.04$, $p = .013$, $\eta_p^2 = .201$; **Fig. 1**). Mood did not affect the overall strength of cultural bias ($F_{(2, 56)} = 0.83$, $p = .441$, $\eta_p^2 = .029$), but there was a significant Language*Mood interaction ($F_{(2, 56)} = 5.55$, $p = .006$, $\eta_p^2 = .165$): For the English language IAT, mood had a significant effect on cultural bias ($F_{(2, 56)} = 4.34$, $p = .018$, $\eta_p^2 = .134$), such that both the positive and negative mood conditions elicited a stronger bias relative to the neutral condition ($t(28) = 2.40$, $p = .023$; $t(28) = 2.45$, $p = .021$), which were moreover comparable ($t(28) = 0.28$, $p = .781$). No such differences in

mood emerged in the Welsh language IAT, however ($F_{(2, 56)} = 1.65$, $p = .200$, $\eta_p^2 = .056$).

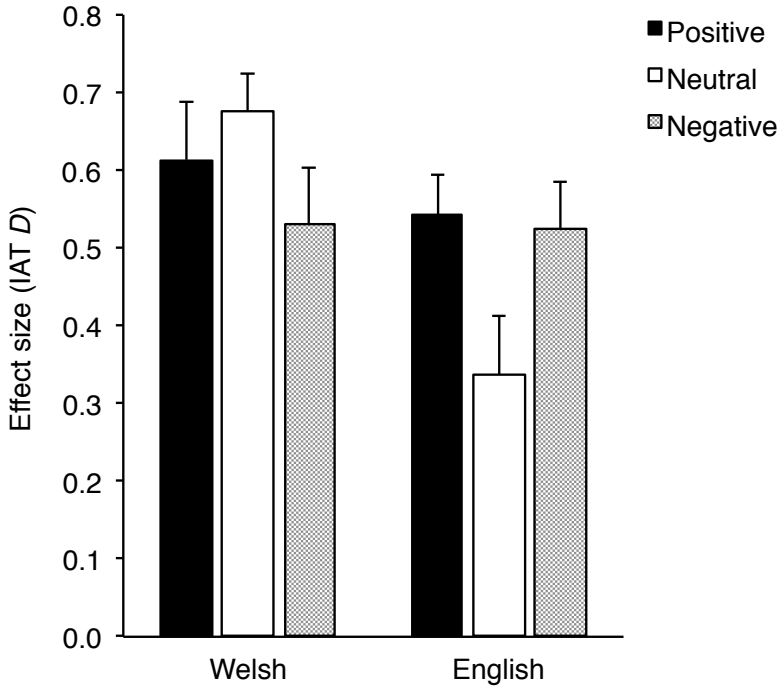


**Figure 1** IAT *D* scores by Test Language and Mood. Positive values indicate a stronger bias for Welsh over English names. Error bars represent SEs.

In order to validate actual changes in mood state during the experiment, global affect scores (positive minus negative sub-scales; **Fig. 2**) were calculated for each PANAS. ANOVA analyses revealed that global affect scores did not differ between languages ($F_{(1, 28)} = 0.07$, $p = .794$, $\eta_p^2 = .002$), but global affect scores did differ between mood conditions ($F_{(2, 56)} = 24.91$, $p = .000$, $\eta_p^2 = .471$): As expected, the positive mood condition ($M = 17.47$, $SE = 1.49$) elicited a larger overall positive affect compared to neutral ($M = 12.16$, $SE = 1.71$; $p = .000$) and negative ($M = 7.19$, $SE = 2.11$; $p = .000$) mood conditions. Neutral and negative scores also significantly differed ($p = .002$). There was no significant interaction between language and mood condition ($F_{(2, 56)} = 0.52$, $p = .599$, $\eta_p^2 = .018$).

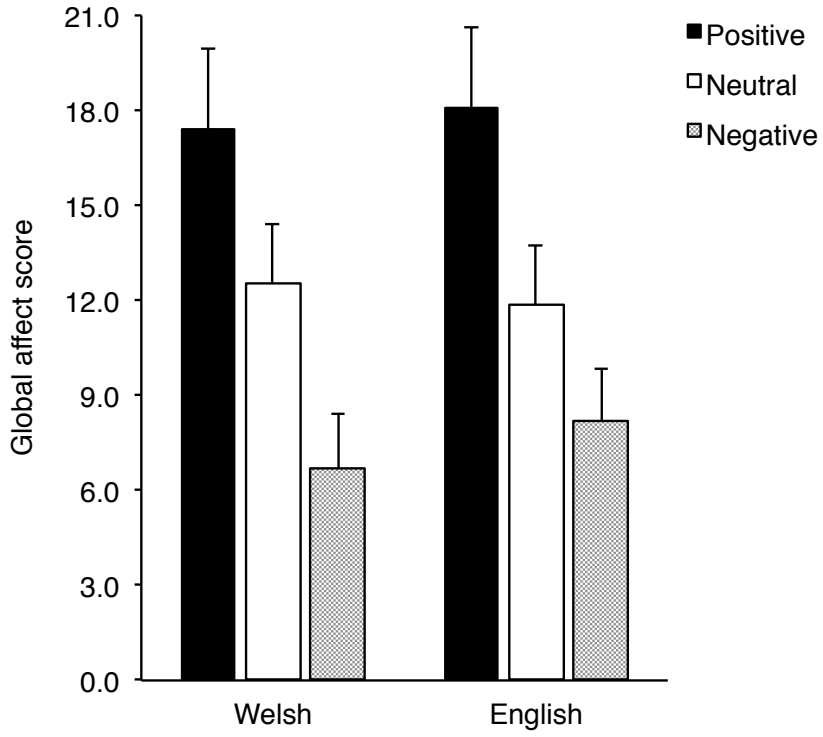


**Figure 2** Global affect scores by Test Language and Mood. Positive values indicate a greater overall positive affect score. Error bars represent SE.

Finally, in order to investigate the relationship between explicit and implicit cultural bias after mood modulation, the mean score calculated from the two subscales of the MEIM ('Identity Search' and 'Affiliation and Belonging') and the D-scores from the IAT were correlated. There were no significant correlational findings (all *r*s < .15, *p*s > .462).

## 6.4 Discussion

We investigated whether the effect of language on implicit cultural attitudes and biases is further modulated by transient emotions. Our findings show that in the absence of any strong mood state (neutral mood condition), language influenced the strength of

in-group cultural biases when participants operated in their first language, Welsh, versus their second language, English. However, affective mood elicitation (both positive and negative affect) was found to differentially affect cultural bias in either language. When operating in their native language, Welsh, participants showed a consistently strong cultural bias, which was present in a neutral mood and was not further enhanced by elicitation of a positive or a negative mood. However, when participants operated in their second language, English, the relatively modest strength of cultural bias observed for the neutral condition contrasted with significantly stronger cultural bias when in a positive or negative mood. Contra our hypotheses, both positive *and* negative moods resulted in greater cultural bias.

However, previous studies have shown that the native language promotes cultural stereotyping, in favour of the in-group (Danziger & Ward, 2010; Ogunnaike et al., 2010). Our results from the neutral condition (baseline) corroborate these findings, but our mood manipulation also adds a crucial new layer of information: In the native language, bilinguals are already maximally biased towards the native culture at baseline, such that an affective state does not further influence this bias. In the second language, bilinguals can be induced to show cultural bias on a par with that shown in the native language, but only when their affective state is high. To explain the differential effect of the native and second language on cultural stereotyping in the IAT task, researchers have focused on the relationship between the native language and the native culture; identifying stronger episodic memories and cultural associations, which lead to the observed automatic biases (e.g, Danziger & Ward,

2010). Whilst we broadly agree with this interpretation, we also argue that the current data plausibly suggests an intrinsic difference in the processing styles elicited by the native and the second language. Specifically, we propose that the native language elicits a heuristic processing style – characterised by greater stereotyping behaviour – whereas the second language elicits a more systematic, analytical processing style – characterised by less stereotyping behaviour. This could explain why elicitation of mood had very little effect in the native language, since the heuristic style is already in place. But in the second language, elicitation of mood effectively switches the analytical style into a heuristic mode, resulting in the observed increase in cultural bias (e.g., Dewaele, 2004; see Hadjichristidis, Geipel, & Savadori, 2015 for a discussion). We note that this interpretation is highly consistent with recent data from our lab and others, indicative of a more rational, systematic processing style in the second language, which probably reflects its greater separation from emotional states, compared with the native language (Costa et al., 2014; Ellis et al., under review; Keysar et al., 2012; Gao et al., 2015; also see Pavlenko, 2012 for a review).

However, whilst it is tempting to assume that the 'cultural bias' demonstrated by these D-scores indicates a similar mechanism (in high mood states) across Welsh and English, it is possible that these apparently comparable biases across languages in fact reflect different processes. Recall that in this IAT, cultural bias comprised a composite of faster and more accurate responses to 'Welsh/good' and 'English/bad' conditions, presenting with the possibility that, for example, Welsh is more sensitive to the 'good' information, whilst English is more sensitive to the 'bad' information. In

the current paradigm, this is difficult to prise apart because of the design of the IAT used, and the scoring procedure used in order to obtain a meaningful effect size (Greenwald, Nosek, & Banaji, 2003).

We also note that our findings in relation to negative mood elicitation were contra expectations. Previous findings have shown a propensity for sad moods to elicit an analytic cognitive processing style, resulting in less biased responses (Lambert, Khan, Lickel, & Fricke, 1997; DeSteno et al., 2010; Park & Banaji, 2000). Our intention, therefore, was for the negative mood manipulation to provide a counterpoint for the positive mood manipulation, which would increase bias. The observations, however, showed increased cultural bias in both moods. We propose two possible reasons for this surprise effect. First, a sad mood has been shown in some studies to elicit a process by which the information shown – and its plausibility – is assessed against the individual's value system, and is therefore prone to social influence (Bodenhausen, Gabriel, & Lineberger, 2000; Englich & Soder, 2009). For example, although images of children fleeing war are not directly relevant to Welsh-English cultural divides, these images may activate cultural attitudes more generally, including social biases. Second, the construct of 'sadness' may be difficult to define and elicit specifically, to the exclusion of other emotions such as anger, frustration etc., all of which may have been aroused implicitly by the film clips shown in the negative mood conditions, and which are associated with a heuristic cognitive processing style.

We did not find any significant correlational between the implicit and explicit measures in this study. This was surprising given that scores on the explicit measure

revealed that our participants self-identified as 'strongly Welsh', however due to this there could have been less variability in the scores to contribute to the correlation. This result however does lend itself to one criticism of the IAT, as many studies have reported a consistent absent or weak relationship between IAT measures and explicit measures (for a meta-analysis on the correlation between implicit and explicit self-report measure see Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005).

To conclude, our findings from the cultural IAT suggest that when bilinguals operate in the native language, they are already display maximal cultural bias, such that an affective state does not further influence this bias. In the second language, bilinguals can be induced to show cultural bias on a par with that shown in the native language, but only when their affective state is elevated. This study demonstrates that emotions - even at the level of transient mood states - are a crucial factor in explaining the relationship between language and social cognition. Moods can selectively influence individuals' cultural biases, depending on the language of operation.

# Chapter 7

General Discussion

## 7.0 Chapter overview

The aim of this thesis was to investigate the effect of language and emotions on cognitive function related to semantic knowledge and attitudes pertaining to culture. Specifically, I asked:

i. **Whether** a particular link exists between the native language and semantic knowledge concerning the native culture, and;
ii. **The nature** of this link, with a specific emphasis on long-term, immutable emotional associations and short-term, transient emotional states. Also, to examine the specificity of the language-culture link as a property of language status in the bilingual mind.

These effects were studied across four experiments that in turn scrutinized the influence of language-culture interactions on semantic processing of verifiable cultural and global knowledge (Chapter 3), the influence of language and emotional content on semantic processing of verifiable cultural knowledge (Chapters 4 and 5), and the influence of transient emotional states on implicit cultural biases (Chapter 6). In this chapter, I will summarize the main results of these studies, interpreting the findings relative to the ***whether***, and ***the nature of*** themes described above, and also within the broader theoretical literature. I then finally propose future directions of study.

## 7.1 Language and culture interact to modulate online semantic processing

I first address the question of:

i. **Whether** a particular link exists between the native language and semantic knowledge concerning the native culture.

The ERP study reported in Chapter 1 extended the recent investigations of linguistic relativity targeting low-level cognitive operations (e.g., Thierry et al., 2009, Boutonnet et al., 2013; Athanasopoulos et al., 2015) to higher-level conceptual knowledge. We presented highly fluent Welsh-English bilinguals with statements that contained cultural information about either the native culture, or global references to culture. Crucially, these sentences were verifiable in terms of a subtle manipulation of truth-value. Results showed that verifiably true cultural information was integrated with more ease – observed via an attenuated N400 effect – when presented in Welsh compared to English, whilst global knowledge was processed similarly in both languages.

In order to contextualise these findings within the framework of the bilingual's two languages, it is firstly important to note how the bilingual lexicon is structured in relation to language and representations. Research on bilingual language processing, and in particular research on the mental lexicon is a topic of debate amongst psycholinguists. Early accounts of the bilingual lexicon included models such as the

word association model (Weinreich, 1953), the conceptual mediation model (Potter, So, Eckhardt, & Feldman, 1984), and the revised hierarchical model (Kroll & Stewart, 1994), whereby a division at the lexical level results in a separate store for L1 and L2 representations. In the latter two models, the conceptual stores at the level of semantic representation were presumed to be linked to both L1 and L2 differentially. However, there is little evidence that supports the view for separate lexicons (see Brysbaert & Duyck, 2010, for a review).

Modern accounts of a joint lexical semantic system now support the theory that both languages of a bilingual are active, even when only one language is in overt use (Morton & Harper, 2007; Costa & Santesteban, 2004; Jared & Kroll, 2001; Guttentag, Haith, Goodman, & Hauch, 1984). Costa and Santesteban (2004) put forth that when accessing words from the mental lexicon, the joint activation of languages leads to either the mediation or interference of retrieval of that particular lexical item. In a novel experiment measuring brain potentials, Thierry and Wu (2007) investigated the influence of semantic information during bilingual lexical access. They showed that when Chinese-English bilinguals were presented with English word pairs that contained a character repetition in Chinese, that co-activation occurred so that this repetition was implicitly detected. These results show that lexical items that are similarly represented on a semantic level can be co-activated in both languages of the bilingual at any given time (Wu & Thierry, 2010; Wu & Thierry, 2013).

The findings from Chapter 1 showed that semantic knowledge pertaining to native cultural information is more readily available in the native language, which

manifests as a decrease in processing effort. Two other studies have shown that the native language increases social bias with respect to cultural attitudes, but this study was the first to show that these language-culture interactions also affect access to *semantic knowledge*. Whilst this experiment was not designed to cast light on the specific mechanism underpinning the language-culture link, we proposed that heightened accessibility to cultural information via the native language likely reflects a lifetime of association and cultural immersion, communicated through the native language (see **Fig. 1**).

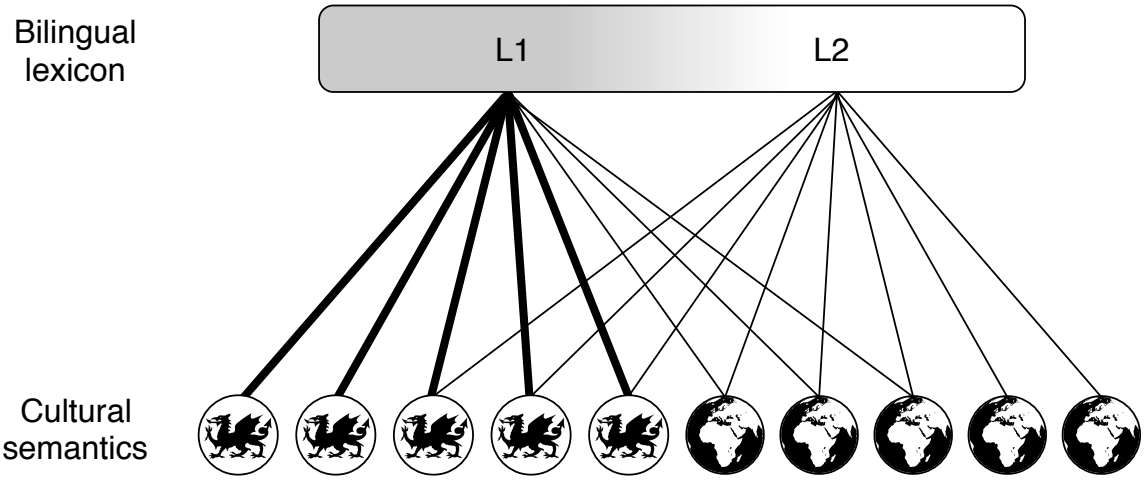


**Figure 1** A schematicized representation of the findings of Chapter 3. Lines represent connections between the two languages of the bilingual and the semantic representations of either native or global (non-native) knowledge. The thicker lines denote increase in the strength of association. The shaded grey area denotes the dominant language.

Whilst the primary aim was to identify language-cultural links per se – using bilingualism as a means of accomplishing this aim – our findings also cast light on the bilingual language system. Accounts of bilingual connectivity between lexical and conceptual 'stores' typically attribute similar weights in terms of access extending from

L1 and L2 to the conceptual level (e.g., Morton & Harper, 2007; Jared & Kroll, 2001; Guttentag, Haith, Goodman, & Hauch, 1984; see Brysbaert & Duyck, 2010, for a review). Our findings and others suggest that concepts in the bilingual mind are differentially accessed by either language, depending on the link between form and concept (e.g., Athanasopoulos et al, 2015). Languages appear to access representations and concepts with different strengths, depending on the link between the two. Importantly, a stronger form-concept link can develop as a function of the features of either the linguistic properties *or* the concept. For example, grammatical gender and lexical overlap has been shown to influence conceptual representations (Boroditsky et al., 2003). Here, we show that the nature of the conceptual representation at the semantic level (related to the native culture, or not) also differentially affects the strength of connectivity from L1 and L2 to that store of knowledge. With reference to modern accounts of bilingualism, postulating full interactivity between bilinguals' language systems (Thierry & Wu, 2007; Wu & Thierry, 2010; Wu et al., 2013), one might predict that phenomena such as lexical and grammatical co-activation can be modulated by the strength of connection (relevance) of a language to the conceptual information being accessed.

## 7.2 The language-culture link is modulated by the processing of emotions

Given the findings discussed above, I next wanted to examine:

ii. **The nature** of this link, with a specific emphasis on long-term, immutable emotional associations and short-term, transient emotional states. Also, to examine the specificity of the language-culture link as a property of language status in the bilingual mind.

To this end, I conducted two studies that examined how bilinguals process positive and negative information concerning the native culture in both the first and second language. The first study investigated this issue in bilinguals for whom the first, or dominant language (L1) is also the language pertaining to the native culture (i.e., the Welsh language pertaining to the Welsh culture). Following data analysis, I decided to examine the perameters of the effects by running an additional study on bilinguals for whom the dominant language is incongruent with the native culture (i.e., the English language pertaining to the Welsh culture).

***The L1 Welsh bilingual study*** comprised an ERP study (Chapter 4), which was designed to extend the findings of Chapter 3 by elucidating the *combined* effects of language and emotion in the processing of native cultural information. We hypothesised that a bias would emerge in our Welsh-English bilinguals, to falsely claim positive information as true, and to deny negative information as false, irrespective of objective truth-value. We expected the patterning of these results to be more pronounced in the L1 compared to the L2, given the postulated stronger link between emotions processing and the L1 (Altarriba, 2008; Pavlenko, 2008; Dewaele, 2004, 2008). N400 modulations showed that participants were sensitive to the truth-

value manipulation of the sentences as per Chapter 3; however, whereas the N400 patterned as expected in the L2 English, the effect was much reduced in the L1 Welsh. Behavioural results showed a categorisation bias for positive statements in both languages, and for negative statements, in only the L2 English. Taken together, the results suggest that when processing information concerning the native culture, processing appeared *less* effective – in terms of access to semantic information – when operating in the L1; an entirely surprising result.

On first pass, these findings appear to run contra the literature to date on the link between languages and emotions processing. As per our hypotheses, one would expect greater sensitivity – and larger effects – in the L1. Indeed, our previous findings demonstrated increased sensitivity in the N400 wave in the L1. However, upon closer inspection, our results are arguably consistent with the literature. I argue that stronger emotional ties to L1 compared to L2 (Altarriba, 2008; Dewaele, 2004, 2008; Pavlenko, 2008), coupled with the native cultural theme of the information, led to vulnerability in the L1 when faced with negative information, characterised by reduced processing efficacy. However, in the L2, the language with greater emotional distance from the native culture (Pavlenko, 2012; Bond & Lai; 1986), participants were able to conduct a more systematic – and perhaps relatively emotionless – defence of the native culture (see **Fig. 2a**).

I also take the opportunity here to justify my selection of the N400 wave over the late positive component (LPC), used in studies of language and emotions processing to reflect semantic appraisal and affective re-evaluation (e.g., Jonczyk et al.,

2016; Citron, 2012; Herbert, Kissler, Junghofer, Peyk, & Rockstroh, 2006). In the current ERP study, we observed a sustained positivity over central parietal electrodes in the 600-900ms time window, which is synonymous with the LPC. However, this positivity could also be attributed to modulation of the P600 wave, which is also known to be maximal in the same time window, and is mostly associated with re-appraisal of a stimulus (e.g., Friederici & Kotz, 2002; Kaan & Swaab, 2003). The difficulty, therefore, in attributing a specific cognitive operation to modulation of the LPC wave – including some controversy concerning the topography of the effect – gave me cause for concern as to how to interpret the effect. It has been associated with cognitive operations such as conflict resolution processes (West, 2003), response selection (West, Jakubek, Wymbs, Perry, & Moore, 2005), in addition to semantic processing (Appelbaum, Meyerhoff, & Woldorff, 2009). Moreover, given the relative subtlety of our manipulation, the sustained positivity seen in our manipulation could simply reflect wrap-up processes involved in the integration of semantic information. Similar work eliciting N400 amplitudes have also found this patterning of late positivity in these electrodes, and have analysed these amplitudes in an exploratory manner (see Jonczyk et al., 2016). More work needs to be done in order to establish the precise time-course involved in emotions processing in order to be able to make substantiated claims as to the processes underlying appraisal of emotional stimuli. Considering these factors, I chose to focus exclusively on modulation of the N400, given its well-known and much cited role as an index of semantic processing (Kutas &

Federmeier, 2011; Kutas & Hillyard, 1980a, 1980b, 1984; Hoshino & Thierry, 2012; Martin et al., 2009).

***The L1 English bilingual study*** (Chapter 5) comprised only behavioural categorisation measurement. The purpose of this experiment was to examine what happens to the privileged language-emotions link as it relates to emotive information (cultural identity) when the bilingual's dominant language is incongruent with the native culture. We hypothesized that if the confounding effects of negative language-culture links are exclusive to the native language associated with the native culture, then we should have obtained the same categorization behaviour as obtained in Chapter 4. Alternatively, we would expect the opposite pattern if the language-culture link is more strongly associated with the dominant language of the bilingual. However, our results in fact showed that these English-Welsh bilinguals were biased against the native culture; an effect that emerged in both languages. These findings suggest that the particular link between language and emotions relating to culture only forms when the native language is also the bilingual's dominant language. When this condition is broken, the bilingual's languages act in unison (see **Fig. 2b**), probably owing to the relative emotional distance between each of the languages and the native culture.

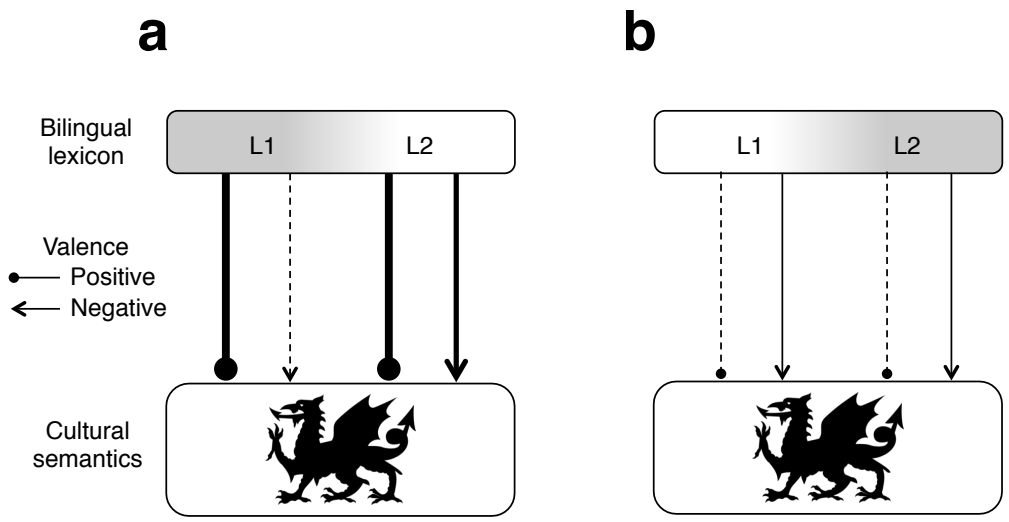


**Figure 2** A schematicized representation of the findings of (a) Chapter 4, and (b) Chapter 5. Lines represent connections between the two language of the bilingual and the either positive or negative valenced semantic representations of the native culture. The thicker lines denote the increase in the strength of association, and the dashed line denotes a weaker strength of association. The shaded grey area denotes the dominant language pertaining to the native culture.

Whilst the current findings pertain to the processing of cultural information, I propose that they may also inform the interaction between language and emotions as they relate to other domains, such as the formation and recall of autobiographical memories (Schrauf, 2000; Schrauf & Rubin, 2003; Marian & Neisser, 2000). The broader scope of these findings would therefore be that language interacts with emotions to potentially affect the consolidation and retrieval of *any* type of information.

## 7.3 Language and *transient emotions* interact to modulate implicit cultural biases

In order to investigate aspects of social cognition tied with aspects of one's personhood, such as cultural identity, in this section I address the remaining aim of the thesis, which was to establish the nature of the language-culture link in relation to transient emotional states.

The study in Chapter 6 was designed to connect two hitherto disparate literatures, to examine whether language interacts with transient emotional states (moods) – the elicitation of which is entirely removed from the native culture – to observe the effect on cultural bias. Welsh-English bilinguals' strength of cultural implicit biases was measured after elicitation of a positive, negative, or neutral mood. In line with previous findings investigating language-culture biases, we hypothesized a stronger pro-Welsh bias when participants operated in their L1 as compared to their L2. We moreover expected that positive mood would result in relatively heightened bias in both languages whereas negative mood would result in minimized cultural effects in both languages. As expected, in the absence of an increased mood state (i.e., a neutral mood), language was found to affect implicit biases, with stronger effects exhibited in the L1. Surprisingly, however, the elicitation of either a positive or negative mood state only affected social biases in the L2. This suggests that cultural biases are fixed with regards to the native language and native culture, but the elicitation of mood in L2 evokes a response that elicits biases similar to that exhibited in the L1 (see **Fig. 3**).

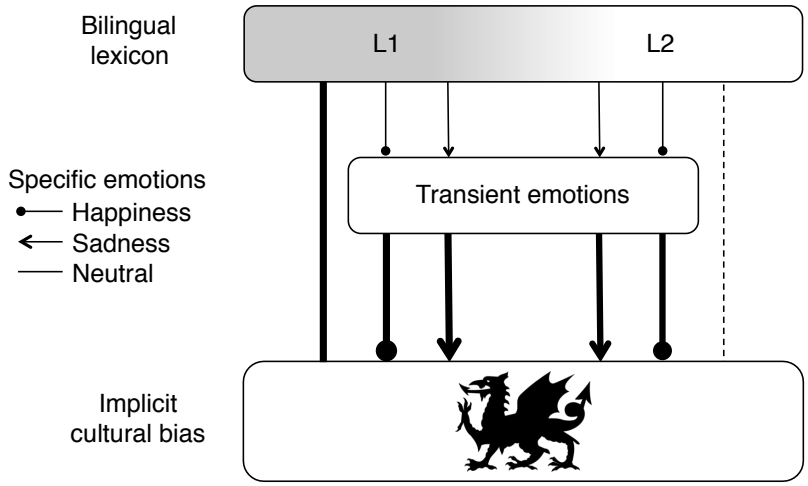


**Figure 3** A schematicized representation of the findings of Chapter 6. Lines represent strength of implicit cultural biases between the two languages of the bilingual and the native culture. The thicker line denotes the increase in the strength of association. The shaded grey area denotes the dominant language of the bilinguals.

In the social cognition literature, increased group bias is considered to indicate an increased tendency to use a heuristic processing style, in which prejudices and biases are more frequently applied, compared with a more rational, analytical processing style (which is in turn associated with a reduction in bias). The baseline differences in our IAT study presents with the intriguing possibility that different languages interact with emotions processing to alter cognitive processing styles. For example, one plausible explanation for our current findings is that, even when in a relatively neutral mood, the L1 Welsh elicited an emotional response to cultural stimuli, which resulted in more heuristic processing. For the L2 English, a more analytical processing style towards cultural stimuli was replaced by a heuristic style when a positive or negative mood was elicited.

Applied to the thesis as a whole, a striking and repeated result, certainly in Chapters 4 and 6, is the observation of interesting effects in the L2 English with

respect to processing emotions and responding to cultural stimuli. I tentatively suggest that these effects occur because of fundamental differences in processing styles between the L1 and L2 in response to cultural information. Under this account, the ingrained emotional connotations of L1 sentences relating to culture in Chapter 4 prompted heuristic processing; with the effect that semantic level information was impaired in L1. In contrast, the L2 – being further removed from the cultural content – allowed analytical processing style. Crucially, however, when bilinguals operate in L2 *and a transient emotional response*, or mood is elicited, the L2 becomes functionally similar to the L1. Thus, I propose that the IAT study may have uncovered the mechanism by which the language-culture link is formed: the L1 becomes associated with the emotive topic of cultural identity, and heightened emotional states, such that during sentence comprehension, these states are accessed along with retrieval of semantic knowledge, resulting in differential processing between L1 and L2 (the assumption being that the L2 does not encode heightened emotional states in relation to cultural information).

Taken together, the findings outlined in this thesis show evidence of linguistic relativity in high level semantic processing and in conceptual representations relating to personhood. Specifically, personal identity with respect to the native culture. The current findings also suggest that the key to understanding the relationship between language and representations of personhood may lie in the emotional connection between the two.

## 7.4 Directions for future studies

Future studies could establish the specificity of the current findings to language, or whether similar effects could be elicited via other cues. Here, I briefly outline a study in progress that examines 'phonological relativity'. In this proposal we (Ellis, Bestelmeyer, & Jones) systematically examine whether the so-called language-culture interaction effects observed in this thesis can also be elicited by acoustic cues signalling cultural identity, such as *accent*, or whether the effects really are specific to *language*.

In this study, identical sentences to those presented in Chapter 3 (Ellis et al., 2015) will be presented via the auditory modality. Sentences will again be presented in Welsh and English, but we also introduce an additional factor: accent. Each Welsh/English sentence is read by speakers with accents typical of North-West Wales (NW) and South-East England (SE).

Research has suggested that accents are a marker of social identity (Labov, 2006), and that members of the social group are sensitive to phonetic and phonological variations that allow individuals to prefer and trust accents that are perceived to be similar to that of their in-group (e.g., Lev-Ari & Keysar, 2010; Coupland & Bishop, 2007; Edwards, 1982). Moreover, recent work has suggested that there is increased social sensitivity and greater emotional sensitivity to accents within the social group, and postulate a neural mechanism for the perception of in-group and out-group accents (Bestelmeyer, Belin, & Ladd, 2015).

The current study aims to map the time-course of these effects. We will measure the auditory N400 event related potential effect in response to our manipulations, which is known to elicit earlier and larger effects as compared to visually presented stimuli (Anderson & Holcomb, 1995; Holcomb & Neville, 1990, 1991). We predict that when presented in Welsh, the in-group NW accent will elicit a cultural bias, and therefore will ease the integration of cultural information, thus reducing N400 amplitude, as per our previous study (Ellis et al., 2015). The crucial question is, whether a similar effect can be elicited by an English sentence, when the speaker speaks in a NW accent, thus providing an implicit 'in-group' cultural membership.

Whilst I note the 'phonological relativity' hypothesis as the most urgent line of enquiry, another avenue I would like to pursue would be the developmental trajectory of language-culture links: when do social biases appear, and the extent to which this is determined by order of language acquisition in bilinguals.

## 7.5 Final remarks

The aim of this thesis was to investigate the evidence for linguistic relativity at higher levels of cognition, including semantic processing, and conceptual representations relating to the self. To investigate this issue, I conducted four experiments, each examining how bilinguals' first and second languages diverge with reference to processing information pertaining to the native culture. In Chapter 3, I showed that that an exclusive language-culture link exists, which modulated online semantic

processing of objectively verifiable information relating to the native culture. Chapters 4 and 5 extended these findings, showing that the emotional valence of sentences is a key moderating factor in the relationship between the native language and the native culture. Chapter 6 showed that whereas cultural biases are fixed in L1, transient emotional states in the L2 can elicit an equivalent level of bias, suggesting that emotions processing drives the language-culture link. Taken together, these studies provide evidence to support the view that language, and cultural contexts are highly dynamic, and play an important role in conceptual processing. Future research is now required to examine the extent to which linguistic relativity – in this context – is truly 'linguistic', and how much can be attributed to the cueing effects of in-group membership, such as accent.

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# Appendix A

## Language and culture modulate online semantic processing

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# Language and culture modulate online semantic processing

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**Language has been shown to influence non-linguistic cognitive operations such as colour perception, object categorization and motion event perception. Here, we show that language also modulates higher level processing, such as semantic knowledge. Using event-related brain potentials, we show that highly fluent Welsh–English bilinguals require significantly less processing effort when reading sentences in Welsh which contain factually correct information about Wales, than when reading sentences containing the same information presented in English. Crucially, culturally irrelevant information was processed similarly in both Welsh and English. Our findings show that even in highly proficient bilinguals, language interacts with factors associated with personal identity, such as culture, to modulate online semantic processing.**

**Keywords:** linguistic relativity; bilingualism; culture; semantics

## INTRODUCTION

Recent research has shown that language affects basic cognitive functions such as perception and object categorization (Thierry *et al.*, 2009; Boutonnet *et al.*, 2012), thus making large strides in resolving the contentious debate surrounding the influence of language on human cognition (Whorf, 1956; Lakoff, 1987; Hunt and Agnoli, 1991; Bowerman and Levinson, 2001; Levinson, 2003). At higher levels of conceptual representation, it is commonly accepted that the semantic level is shared across all languages spoken by an individual (De Groot, 1992; Kroll and Stewart, 1994; La Heij *et al.*, 1996; Van Hell and De Groot, 1998; Gollan and Kroll, 2001). However, recent evidence suggests that the language of operation also affects higher level representations, as is the case in the domain of lexically driven semantic associations (Boutonnet *et al.*, 2014) and motion conceptualization (Kersten *et al.*, 2010; Athanasopoulos *et al.*, 2015). Here, we provide the first empirical, neurophysiological evidence that the language in which someone operates interacts with personal factors such as cultural identity to modulate online semantic processing during sentence comprehension.

Behavioural studies have shown that language shapes conceptual information. Abstract linguistic idiosyncrasies, such as arbitrary male–female gender marking, influence the perception of semantically gender–neutral objects (Boroditsky, 2001; Boroditsky *et al.*, 2003), and the effect of factors relating to personhood, such as cultural biases induced by native personal pronouns, is heightened when information is presented in the native language (Danziger and Ward, 2010; Ogunnaike *et al.*, 2010). However, such findings remain sparse and limited to single nouns and pronouns. The link between language and personhood, which is a defining feature of culture, may therefore be redolent of phenomena such as the implicit activation of racial attitudes and biases [see Fiedler *et al.*, 2006, for a critique of the Implicit Association Task (IAT)], but it remains unknown whether the languages spoken by an individual each interact differently with culture to affect 'comprehension'. This distinction is important, in that evocation of attitudes is generally conceived as an automatic, 'knee-jerk' reaction to a stimulus, whereas comprehension refers to semantic analysis, synthesis and understanding of linguistic information.

In this study, we tested whether language and cultural factors may interact to modulate sentence comprehension in fluent, early adult Welsh–English bilinguals. We recorded electrophysiological responses in bilingual participants reading Welsh and English sentences. Half of the sentences in each language contained culturally relevant information; the other half referred to culturally non-relevant facts, that is, generic semantic knowledge. Furthermore, and in order to implement a suitable cognitive task, half of the sentences formed a true premise and the other half a false one (Table 1). Semantic processing was indexed by the amplitude of the N400 wave of the event-related potential (ERP) elicited by the sentence-final word, identical between experimental conditions. N400 amplitude is modulated by the extent to which the target word fits the semantic context in which it is presented, with increasing negative amplitude indexing greater energy required for semantic integration (Kutas and Federmeier, 2011). Current theorizing on N400 modulation implicates lexical retrieval from long-term memory, which is facilitated by top-down context information from the preceding sentence fragment (Van Berkum, 2009; Brouwer *et al.*, 2012). In the current experiment, participants pressed buttons to indicate whether each presented statement was true or false, thus providing a direct measure of sentence comprehension. We predicted reduced N400 amplitudes for words completing a true statement as compared with these same words completing a false statement by virtue of the fact that true statements are naturally more expected than false ones. We further hypothesized a differential effect of language for culturally relevant content, and thus expected to find an interaction between language and cultural relevance. More specifically, we anticipated a greater true–false N400 disparity for information about Wales or Welsh people presented in Welsh as compared with the same information presented in English. Such an interaction would indicate that semantic processing is indeed different in the two languages insofar as they shed a different light on culturally relevant information.

## MATERIALS AND METHODS

### Participants

Eighteen balanced Welsh–English bilinguals with normal or corrected vision (1 male, 17 women; $M = 22.06$ years, s.d. $= 5.03$) were included in the analysis. Five participants were excluded because they had too

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**Table 1** Experimental design and example of a sentence set

| Sentence | Premise | Cultural relevance |
|---|---|---|
| a—Presented in English[a] | | |
| Every single Welsh child can sing in ***tune*** | False | Relevant |
| Opera at the National Welsh Theatre is always in ***tune*** | True | Relevant |
| Good quality antique instruments always stay in ***tune*** | False | Non-relevant |
| Before a professional concert, a piano is always in ***tune*** | True | Non-relevant |
| b—Presented in Welsh[a] | | |
| The National Welsh Theatre is the only venue where opera is in ***tune*** | False | Relevant |
| A lot of Welsh children can sing in ***tune*** | True | Relevant |
| The piano is the only instrument that stays in ***tune*** | False | Non-relevant |
| Old instruments are quite likely to be out of ***tune*** | True | Non-relevant |

[a]Counterbalanced across participants.

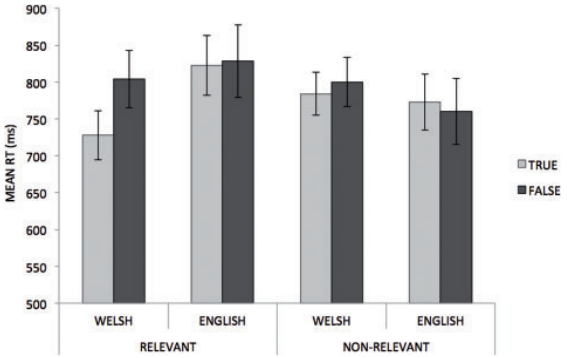


**Fig. 1** Mean RTs (ms) for correct true/false responses to culturally relevant or non-relevant statements presented in Welsh or English. Error bars represent SEM.

few artefact-free epochs per condition. Participants self-reported that they were L1 Welsh speakers, having been exposed to English from an early age ($M = 4.22$ years, s.d. $= 2.88$). The sample reported, on average, 66% L1 and 34% L2 usage in everyday interactions, including bilingual educational instruction. Ethical approval was granted by the School of Psychology, Bangor University ethics committee, and participants gave written consent.

### Stimuli and procedure

A total of 40 English sentence sets and 40 Welsh translation equivalents were constructed. In each language, each set consisted of 8 sentences ending in the same final word. Participants were presented with 4 sentences from the English set, and 4 different sentences from the Welsh set (Table 1). Thus, for any given participant, each experimental sentence was not repeated, not even by way of a translation equivalent. Of these sentences, the language factor (English *vs* Welsh) was crossed with a cultural relevance factor (relevant *vs* non-relevant) and a truth-value factor (true *vs* false). The procedure included two important counterbalancing features: (i) the truth value (true *vs* false) of sentences containing a particular referent (e.g. 'instruments') was inverted between languages of presentation and (ii) the language of sets a and b was fully rotated between participants.

In a separate pre-test, 20 participants who did not take part in the experiment proper were asked to complete the sentences with the first 3 words that came to mind. If one of the completions matched our experimental sentences, a score of 1 was given. All other answers were given a score of 0. When scores were averaged across sentences, a cloze probability of 42% was obtained, which was above our threshold of 40% (Coulson *et al.*, 2006), and there was no significant difference between conditions ($P > 0.05$). Sentence-final target words were controlled for written frequency, word and syllable length ['Cronfa Electroneg o Gymraeg' (Welsh), Ellis *et al.*, 2001; CELEX lexical database (English), Baayen *et al.*, 1993]. Each participant thus read 320 sentences in total presented in 8 experimental blocks.

Stimuli were presented in white courier new 18 point font on a black background on a 19-inch cathod ray tube (CRT) monitor with a refresh rate of 75 Hz. The first clause of each sentence was presented all at once and reading was self-paced, followed by single word presentations in the centre of the screen for 200 ms with an inter-stimulus interval of 500 ms (so as to prevent eye movements upon presentation of the final word). Presentation order was pseudorandomized such that participants would not encounter the same final word within the same block. Following each sentence, participants made a yes/no judgement regarding the truth value of each statement.

### ERP recording

Electrophysiological data were recorded from 64 Ag/AgCl electrodes according to the extended 10–20 convention, referenced to the Cz electrode at a rate of 1 kHz. Impedances were kept below 5 kΩ. Electroencephalogram activity was filtered online with a band-pass filter between 0.1 and 200 Hz and offline using a low-pass, zero phase shift digital filter with a cut-off frequency of 20 Hz. Eye blink artefacts were corrected mathematically using the procedure proposed by Gratton *et al.* (1983), and remaining artefacts were removed manually upon visual inspection of the data. Epochs ranged from −100 to 1000 ms after final word onset. Epochs with activity exceeding ± 75 μV at any electrode site over the scalp were discarded. Baseline correction was performed in reference to pre-stimulus activity and individual averages were digitally re-referenced to the global average reference.

## RESULTS

Analyses were conducted on 79% of the data, that is, sentences that were accurately verified as true or false (cf. Martin *et al.*, 2014). Repeated measures ANOVAs were conducted with language (Welsh *vs* English), cultural relevance (relevant *vs* non-relevant) and Truth value (true *vs* false) as independent variables.

### Behavioural data

Analysis of variances (ANOVAs) on reaction time data yielded no main effects of cultural relevance ($F_{(1,\ 17)} = 1.15$, $P > 0.05$), language ($F_{(1,\ 17)} = 0.35$, $P > 0.05$) or truth value ($F_{(1,\ 17)} = 1.23$, $P > 0.05$). A language by truth value interaction ($F_{(1,\ 17)} = 4.81$, $P = 0.042$) showed that in the case of Welsh sentences, true statements were responded to more quickly than false ones, whereas statements in English were responded to with similar speed independent of truth value. There was also a language by cultural relevance interaction ($F_{(1,\ 17)} = 10.71$, $P = 0.004$) such that culturally relevant statements were responded to more quickly than non-relevant statements when sentences were presented in Welsh, but no such difference was found for statements in English. No other interactions emerged from the reaction time data (Figure 1). A correlation analysis by subjects revealed no evidence of a speed–accuracy trade-off ($r(1, 18) = 0.09$, $P = 0.73$).

### Electrophysiological data

We analysed ERP amplitudes over 10 electrodes over which the N400 is known to be maximal (linear derivation of Cz, C1, C2, C3, C4, CPz, CP1, CP2, CP3, CP4; Kutas and Hillyard, 1980a,b, 1984; Martin *et al.*, 2009; Hoshino and Thierry, 2012; see also Kutas and Federmeier, 2011; Luck, 2014, p. 52) (Figure 2). As expected, there was a main effect of

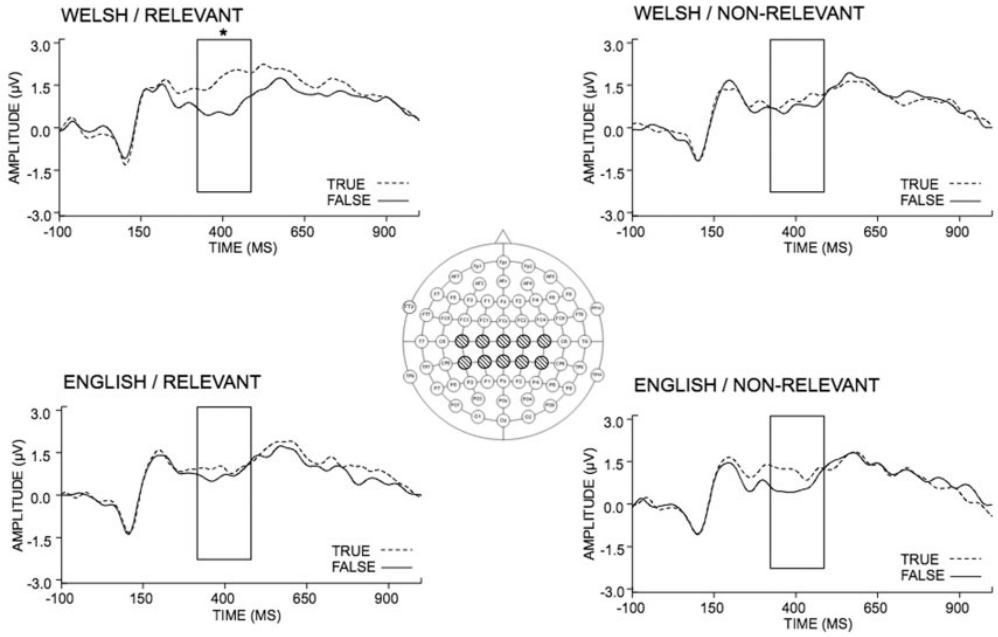


**Fig. 2** ERPs (μV) elicited by true/false sentences containing culturally relevant or culturally non-relevant information and presented in either Welsh or English. The asterisk indicates the window of analysis in which mean ERP amplitudes significantly differed between conditions (340–450 ms post-stimulus).

truth value ($F_{(1,\ 17)} = 19.65$, $P < 0.001$), such that the N400 was reduced in amplitude for true relative to false statements and no other main effects (cultural relevance: $F_{(1,\ 17)} = 1.71$, $P > 0.05$; language: $F_{(1,\ 17)} = 1.43$, $P > 0.05$) or two-way interactions (language and truth: $F_{(1,\ 17)} = 1.35$, $P > 0.05$; language and culture: $F_{(1,\ 17)} = 2.28$, $P > 0.05$; truth and culture: $F_{(1,\ 17)} = 1.34$, $P > 0.05$) emerged.

Critically, we found a significant three-way interaction among language, cultural relevance and truth value ($F_{(1,\ 17)} = 6.01$, $P = 0.025$). Planned comparisons on the N400 effect (true–false) in the different conditions showed that the N400 was significantly larger for Welsh than English in the culturally relevant conditions ($t(17) = 3.12$, $P = 0.006$; Figures 2 and 3), whereas no language difference was found for culturally non-relevant sentences ($t(17) = -0.95$, $P > 0.05$).

Overall, our results show that for statements containing information about Wales, the N400 effect is larger when these statements are presented in Welsh than in English. Importantly, this finding is not due to a generic/overall preference for the Welsh language because no language differences were found for general statements.

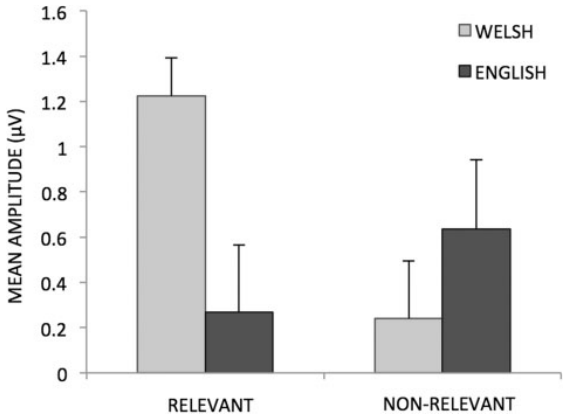


**Fig. 3** Mean amplitude (μV) of the N400 effect (truth–false) for culturally relevant and non-relevant statements presented in Welsh or English. Error bars represent SEM.

## DISCUSSION

We investigated whether the language we speak can influence the way in which we understand detailed, sentence-level information, using the N400 ERP wave as an index. Our findings indicate that language interacts with cultural identity during semantic processing. More specifically, we show that true, culturally relevant information about Wales is integrated with more ease when it is presented in Welsh than in English, even though English translation equivalents are supposed to convey identical information. In contrast, culturally non-relevant information is not processed differently between languages. To our knowledge, this is the first demonstration that information intimately linked with the native language (e.g. because of the emotional context in which knowledge is acquired) is processed more readily in that language than in another language acquired subsequently. Language therefore affects cognition even at the subtlest levels of semantic knowledge.

It is noteworthy that the ERP modulations reflecting online semantic processing at 400 ms post stimulus were broadly consistent with behavioural reaction time (RT) sentence-verification data acquired simultaneously: Factually correct and culturally relevant information yielded shorter RTs, supporting the interpretation of easier semantic processing when language and cultural references are aligned.

We believe that these findings significantly extend insights into linguistic relativity effects. Previous electrophysiological studies have shown an influence of language on basic cognitive functions such as perception and object categorization (Thierry *et al.*, 2009; Athanasopoulos *et al.*, 2010; Boutonnet *et al.*, 2013). Furthermore, emotional words have been shown to have a different resonance or

impact on the first and second language of bilinguals (Dewaele, 2004; Wu and Thierry, 2012), but the effect of language on higher order levels of semantic processing such as cultural relevance has seldom been observed. Recent studies using the IAT suggest that language and culture interact in complex ways (Danziger and Ward, 2010; Ogunnaike *et al.*, 2010). In both studies, bilinguals showed faster responses to native personal pronouns paired with positive adjectives (such as 'good') when the task was performed in the native relative to the non-native language. The authors concluded that language serves as a cue for the activation of certain racial biases (Briley *et al.*, 2005; Danziger and Ward, 2010).

Our study also shows that the languages spoken by a bilingual do not equally convey cultural mores, such that a statement may not be understood in the same way at all depending on its reference to the speaker's native culture. Thus, linguistic relativity is not confined to automatic reactions defining attitudes, prejudice or belief (Briley *et al.*, 2005). 'False' statements in our study involved fairly subtle misinformation, conforming to folk wisdom and national pride (e.g. 'Welsh collies are the most intelligent breed of dog'). However, the N400 for false, culturally relevant statements presented in Welsh was not attenuated in the same way as true, culturally relevant statements presented in Welsh. Thus, our findings suggest that language specifically influences online processing of real, verifiable semantic knowledge when it relates to culturally relevant information. Importantly, any modulation of the N400 in this study must have originated from the language used, because the semantic sentence context and critical final word were identical across language conditions (Kutas and Federmeier, 2011). We also note here that the duration of the N400 was sustained beyond the usual range (typically ~250–550 ms, e.g. Kutas and Hillyard, 1980b; Hagoort *et al.*, 2004), which is perhaps to be expected given the relative subtlety of our true/false manipulation, leading to prolonged content evaluation or decision-making processes (Osterhout and Nicol, 1999; Hagoort, 2003; Hagoort *et al.*, 2003; Martín-Loeches *et al.*, 2006).

To conclude, our study provides the first neurophysiological demonstration that the language we speak interacts with personal factors such as cultural identity to modulate online semantic processing during sentence comprehension, one of the most sophisticated cognitive abilities of the human brain. The mechanism underlying these effects remains unknown, but is likely to involve episodic memory and the limbic system, both of which are known to be shaped by one's cultural experience (Marian and Neisser, 2000; Schrauf, 2000; Marian and Kaushanskaya, 2004; Danziger and Ward, 2010). Future studies will hopefully shed more light on the existence and permanence of these effects across development and in bilingual adults with varying degrees of proficiency.

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# Appendix B

## Experimental sentences used in Chapter 3

**Set *a* - English Sentences**

| | Sentence | Truth-value | Cultural Relevance |
|---|---|---|---|
| 1 | All Welsh children can sing in tune. | False | Relevant |
| 2 | Opera at the National Welsh Theatre is always in tune. | True | Relevant |
| 3 | Good quality antique instruments always stay in tune. | False | Non-Relevant |
| 4 | Before a professional concert, a piano is always in tune. | True | Non-Relevant |
| 5 | Lovespoons promote fertility in a marriage. | False | Relevant |
| 6 | Welsh people often go to chapel for a marriage. | True | Relevant |
| 7 | If you are caught smoking, it will be the end of your marriage. | False | Non-Relevant |
| 8 | Couples sign a registry to confirm a marriage. | True | Non-Relevant |
| 9 | Of the Celtic nations, Welsh rugby supporters drink the most alcohol. | False | Relevant |
| 10 | Welsh breweries are renowned for the quality of their alcohol. | True | Relevant |
| 11 | You must reach fifteen years of age to drink alcohol. | False | Non-Relevant |
| 12 | Yorkshire produces several types of alcohol. | True | Non-Relevant |
| 13 | The Welsh dragon can be seen on every flag. | False | Relevant |
| 14 | In Britain, Wales is the only nation without stripes on its flag. | True | Relevant |
| 15 | In America, every home displays a flag. | False | Non-Relevant |
| 16 | When man landed on the moon, they left a flag. | True | Non-Relevant |
| 17 | Daffodils are the first flower to bloom in the month of March. | False | Relevant |
| 18 | St. David's day falls on the first of March. | True | Relevant |
| 19 | The beginning of summer is in the month of March. | False | Non-Relevant |
| 20 | The third month of the year is the month of March. | True | Non-Relevant |
| 21 | In the Mabinogi, every maiden is made of flowers. | False | Relevant |
| 22 | After the ceremony of the bards comes the dance of flowers. | True | Relevant |
| 23 | The sweetest honey is made with the brightest types of flowers. | False | Non-Relevant |
| 24 | It is possible to make wine with some types of flowers. | True | Non-Relevant |
| 25 | As a nation, Wales has the oldest anthem. | False | Relevant |
| 26 | Before a rugby match, players sing the anthem. | True | Relevant |
| 27 | French is the language used to sing every anthem. | False | Non-Relevant |
| 28 | Most countries have an anthem. | True | Non-Relevant |
| 29 | For most people in Wales, Welsh is their first language. | False | Relevant |
| 30 | Welsh is a form of Celtic language. | True | Relevant |
| 31 | Every country has a different language. | False | Non-Relevant |
| 32 | Globally, Chinese is the most frequently used language. | True | Non-Relevant |
| 33 | At all Welsh weddings, one can hear the harp. | False | Relevant |
| 34 | The instrument most associated with Wales is the harp. | True | Relevant |
| 35 | There are thousands of strings on a harp. | False | Non-Relevant |
| 36 | Wood is the main material of a harp. | True | Non-Relevant |
| 37 | In Britain, Snowdon is the tallest of mountains. | False | Relevant |
| 38 | Every county in Wales contains hills or mountains. | True | Relevant |
| 39 | Trees only grow at the top of a mountain. | False | Non-Relevant |
| 40 | Magma from volcanoes can create mountains. | True | Non-Relevant |
| 41 | Welsh princes were trained by Merlin to be strong. | False | Relevant |
| 42 | Welsh castles were built to be strong. | True | Relevant |

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| 43 | In Africa, the wind blows cold and strong. | False | Non-Relevant |
| 44 | Some nuts have shells that are very strong. | True | Non-Relevant |
| 45 | Our slate has provided roofs for houses in every country. | False | Relevant |
| 46 | Mining was a core industry in our country. | True | Relevant |
| 47 | Spanish is a language taught in every country. | False | Non-Relevant |
| 48 | Africa is a continent rather than a country. | True | Non-Relevant |
| 49 | Welsh wool makes the warmest clothes. | False | Relevant |
| 50 | A bonnet and an apron are traditional Welsh clothes. | True | Relevant |
| 51 | You must use felt to make clothes. | False | Non-Relevant |
| 52 | China manufactures and exports the greatest amount of clothes. | True | Non-Relevant |
| 53 | We know that Owain Glyndwr was never killed. | False | Relevant |
| 54 | Cilmeri is the site where Llywelyn The Last was killed. | True | Relevant |
| 55 | In the Afghanistan war, Nelson was killed. | False | Non-Relevant |
| 56 | Gladiators fought until one was killed. | True | Non-Relevant |
| 57 | In Europe, Wales has the highest number of farmers. | False | Relevant |
| 58 | Sheep and cattle are bought by farmers. | True | Relevant |
| 59 | Tea leaves are only picked by farmers. | False | Non-Relevant |
| 60 | Coffee plantations are run by farmers. | True | Non-Relevant |
| 61 | In British football, Wales has the best players. | False | Relevant |
| 62 | The Welsh rugby team is well known for the high standard of their players. | True | Relevant |
| 63 | In ice skating, Britain has the best players. | False | Non-Relevant |
| 64 | American basketball teams have many tall players. | True | Non-Relevant |
| 65 | In Britain, Welsh pastures grow the fastest after the rain. | False | Relevant |
| 66 | Welsh beaches are popular to visit when there is no rain. | True | Relevant |
| 67 | Tourists travel to the Alps for the rain. | False | Non-Relevant |
| 68 | The Amazon forest receives a lot of rain. | True | Non-Relevant |
| 69 | In Wales, everyone has a natural talent for making music. | False | Relevant |
| 70 | Wales has a strong tradition of folk music. | True | Relevant |
| 71 | All teenagers enjoy the old traditional types of music. | False | Non-Relevant |
| 72 | In Texas, 'country' is a popular type of music. | True | Non-Relevant |
| 73 | The Eisteddfod is history's oldest competition. | False | Relevant |
| 74 | Wales has a good landscape for the World rally competition. | True | Relevant |
| 75 | In schools, cash is given as prizes in all competitions. | False | Non-Relevant |
| 76 | People run a marathon as a competition. | True | Non-Relevant |
| 77 | You can find the Welsh poppy in all gardens. | False | Relevant |
| 78 | Wales is famous for some of its gardens. | True | Relevant |
| 79 | Japan is well known for the oak trees in their gardens. | False | Non-Relevant |
| 80 | In cities, people can have rooftop gardens. | True | Non-Relevant |
| 81 | In Britain, Welsh is featured on all signs. | False | Relevant |
| 82 | The Welsh language society used green paint to vandalise signs. | True | Relevant |
| 83 | Hollywood has huge green letters for its sign. | False | Non-Relevant |
| 84 | A one-way street is denoted by an arrow on the sign. | True | Non-Relevant |
| 85 | According to legend, King Arthur killed the bear with a stone. | False | Relevant |
| 86 | At the National Eisteddfod, there is always a circle of stones. | True | Relevant |
| 87 | All houses are built using stones. | False | Non-Relevant |
| 88 | Diamonds are types of precious stones. | True | Non-Relevant |

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|---|---|---|---|
| 89 | At the Royal Welsh Show, you will see the world's best quality animals. | False | Relevant |
| 90 | On Welsh farms, sheep are the most common animals. | True | Relevant |
| 91 | Every family owns animals. | False | Non-Relevant |
| 92 | Zoos tend to house many species of wild animals. | True | Non-Relevant |
| 93 | The Welsh collie is the most intelligent type of dog. | False | Relevant |
| 94 | According to Llywelyn's legend, Gelert was a brave dog. | True | Relevant |
| 95 | In China, the most popular pet to own is a dog. | False | Non-Relevant |
| 96 | The Great Dane is one of the largest breeds of dog. | True | Non-Relevant |
| 97 | Welsh coal mines are the deepest under the earth. | False | Relevant |
| 98 | Olwen's footprints left white flowers growing on the earth. | True | Relevant |
| 99 | In the Spring, leaves fall to earth. | False | Non-Relevant |
| 100 | Potatoes are a vegetable that grow in the earth. | True | Non-Relevant |
| 101 | Wales has the purest form of gold. | False | Relevant |
| 102 | Clogau is the Welsh mine famous for its gold. | True | Relevant |
| 103 | All coins are made of gold. | False | Non-Relevant |
| 104 | Carats measure the weight of gold. | True | Non-Relevant |
| 105 | In Europe, Bara Brith is the most consumed loaf. | False | Relevant |
| 106 | An oven is traditionally used for making Welsh loaves. | True | Relevant |
| 107 | A cheese grater is required when baking a loaf. | False | Non-Relevant |
| 108 | Flour and water are used to make a loaf. | True | Non-Relevant |
| 109 | The English came to Wales and were conquered. | False | Relevant |
| 110 | Owain Glyndwr fought the English but never truly conquered. | True | Relevant |
| 111 | The Vikings sailed to America and conquered. | False | Non-Relevant |
| 112 | The Romans came to Britain and conquered. | True | Non-Relevant |
| 113 | All Welsh actors are famous in America. | False | Relevant |
| 114 | Welsh settlers migrated to a remote area of South America. | True | Relevant |
| 115 | The largest country in the world is America. | False | Non-Relevant |
| 116 | English is the most spoken language in America. | True | Non-Relevant |
| 117 | The Millenium stadium is the largest in the world. | False | Relevant |
| 118 | Some Welsh choirs are famous around the world. | True | Relevant |
| 119 | The Eiffel tower is the largest building in the world. | False | Non-Relevant |
| 120 | The cheetah is the fastest animal in the world. | True | Non-Relevant |
| 121 | The Mabinogion are the most popular stories about magic. | False | Relevant |
| 122 | Druids were believed to practise magic. | True | Relevant |
| 123 | Houdini could escape from traps using magic. | False | Non-Relevant |
| 124 | Harry Potter is a fictional character known for his magic. | True | Non-Relevant |
| 125 | Wales has the best quality oak for making furniture. | False | Relevant |
| 126 | A three-piece dresser is an example of traditional Welsh furniture. | True | Relevant |
| 127 | You must own a house before buying furniture. | False | Non-Relevant |
| 128 | In the UK, pine is the most widely used wood to make furniture. | True | Non-Relevant |
| 129 | In Wales, you have to be an educated bard to write poetry. | False | Relevant |
| 130 | Dylan Thomas was famous for writing poetry. | True | Relevant |
| 131 | No two lines can rhyme in poetry. | False | Non-Relevant |
| 132 | William Wordsworth was famous for his poetry. | True | Non-Relevant |
| 133 | Welsh people are special and unique because of their genes. | False | Relevant |
| 134 | Celtic heritage can be traced in our genes. | True | Relevant |

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|---|---|---|---|
| 135 | Only mothers pass on genetic traits through their genes. | False | Non-Relevant |
| 136 | The 'human genome project' will identify all human genes. | True | Non-Relevant |
| 137 | Wales has the purest form of bottled water. | False | Relevant |
| 138 | According to legend, Excalibur was thrown into the water. | True | Relevant |
| 139 | The earth's surface has more land than water. | False | Non-Relevant |
| 140 | To be healthy, it is important to drink plenty of water. | True | Non-Relevant |
| 141 | Dafydd Iwan became the British Prime Minister whilst a politician. | False | Relevant |
| 142 | Lloyd George was a successful politician. | True | Relevant |
| 143 | Every lawyer must be a politician. | False | Non-Relevant |
| 144 | Every Prime Minister must be a politician. | True | Non-Relevant |
| 145 | The Millenium Stadium is a theatre. | False | Relevant |
| 146 | Plays and operas are performed in Wales in our theatre. | True | Relevant |
| 147 | Shakespeare's plays are only performed at his Globe theatre. | False | Non-Relevant |
| 148 | In the UK, London has the most theatres. | True | Non-Relevant |
| 149 | From the Lowland Hundred it is possible to hear the bells. | False | Relevant |
| 150 | On Sundays, Welsh churches traditionally ring their bells. | True | Relevant |
| 151 | Midnight is the only time when you can hear the Big Ben bell. | False | Non-Relevant |
| 152 | In palaces, servants are summoned with bells. | True | Non-Relevant |
| 153 | In the Eisteddfod, Hedd Wyn was the first winner of the main prize. | False | Relevant |
| 154 | At an Eisteddfod, poets receive a chair as a prize. | True | Relevant |
| 155 | Every competition gives cash as a prize. | False | Non-Relevant |
| 156 | In the Olympics, the gold medal is highest prize. | True | Non-Relevant |
| 157 | Locally, every village in Wales has a pub. | False | Relevant |
| 158 | Traditionally, men would sing hymns in the pub. | True | Relevant |
| 159 | You cannot take children to a pub. | False | Non-Relevant |
| 160 | You can usually get a meal in a pub. | True | Non-Relevant |

**Set *a* - Welsh Sentences**

| | **Sentence** | **Truth-value** | **Cultural Relevance** |
|---|---|---|---|
| 161 | Theatr Genedlaethol Cymru yw'r unig lleoliad lle mae opera mewn tiwn. | False | Relevant |
| 162 | Mae llawer o blant Cymreig yn gallu canu mewn tiwn. | True | Relevant |
| 163 | Y piano yw'r unig offeryn sydd yn aros mewn tiwn. | False | Non-Relevant |
| 164 | Mae offerynau hen yn debygol o fod allan o diwn. | True | Non-Relevant |
| 165 | Y capel yw'r unig lle i bobl Cymreig briodi. | False | Relevant |
| 166 | Yn aml, rhoddir llwyau cariad fel rhan o briodas. | True | Relevant |
| 167 | Mae'n rhaid i westai gofrestru cyn mynychu seremoni priodasol. | False | Non-Relevant |
| 168 | Gallwch ysmygu a dal parhau gyda eich priodas. | True | Non-Relevant |
| 169 | Mae pob pentref yng Nghymru yn cynhyrchu math unigryw o alcohol. | False | Relevant |
| 170 | Mae cefnogwyr rygbi Cymru fel arfer yn yfed llawer o alcohol. | True | Relevant |
| 171 | Bragdai Efrog sy'n cynhyrchu'r mathau cryfaf o alcohol. | False | Non-Relevant |
| 172 | Mewn tafarn, rhaid bod yn ddeunaw oed i brynu alcohol. | True | Non-Relevant |
| 173 | Ym Mhrydain, mae Cymru yn cael ei chynrychioli ar y brif faner. | False | Relevant |
| 174 | Y Ddraig Goch yw'r symbol ar y faner. | True | Relevant |
| 175 | Ar y lleuad, mae nifer o wledydd wedi gadael baner. | False | Non-Relevant |

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|---|---|---|---|
| 176 | Yn America, cynrychiolir pob talaith gan seren ar y faner. | True | Non-Relevant |
| 177 | Mae Dydd Gwyl Dewi Sant bob tro yn disgyn ar ddydd Sul cyntaf mis Mawrth. | False | Relevant |
| 178 | Mae Cennin Pedr yn aml wedi blodeuo erbyn mis Mawrth. | True | Relevant |
| 179 | Pedwerydd mis y flwyddyn yw mis Mawrth. | False | Non-Relevant |
| 180 | Y mis sydd yn dilyn Chwefror yw mis Mawrth. | True | Non-Relevant |
| 181 | Mae aelodau o orsedd y beirdd yn cario blodau. | False | Relevant |
| 182 | Yn y Mabinogi, roedd merch hardd wedi ei gwneud o flodau. | True | Relevant |
| 183 | Mae pob gwin melys wedi'w wneud gyda blodau. | False | Non-Relevant |
| 184 | I wneud mêl, mae gwenyn angen blodau. | True | Non-Relevant |
| 185 | Mae pob chwarewr rygbi Cymru yn gwybod y geiriau i'r anthem. | False | Relevant |
| 186 | Yn ysgol, mae plant Cymreig yn dysgu i ganu'r anthem. | True | Relevant |
| 187 | Mae gan pob gwlad sawl anthem. | False | Non-Relevant |
| 188 | Bydd gwledydd fel arfer yn defnyddio eu hiaith brodorol ar gyfer canu yr anthem. | True | Non-Relevant |
| 189 | Ledled y byd, Cymraeg yw'r hynaf o ran iaith. | False | Relevant |
| 190 | Mae pobl sy'n byw yng Nghymru yn ymwybodol o'r iaith. | True | Relevant |
| 191 | Ledled y byd, Saesneg a ddefnyddir y rhan amlaf o ran iaith. | False | Non-Relevant |
| 192 | Mae llawer o wledydd yn rhannu yr un iaith. | True | Non-Relevant |
| 193 | Mae pob plentyn Cymreig yn dysgu i chwarae'r delyn. | False | Relevant |
| 194 | Offeryn sy'n poblogaidd i'w gael mewn priodasau Cymreig yw'r delyn. | True | Relevant |
| 195 | Aur yw'r prif ddeunydd a ddefnyddir i wneud telyn. | False | Non-Relevant |
| 196 | Mae llawer o linynau ar y delyn. | True | Non-Relevant |
| 197 | Roedd cewri Cymreig yn brasgamu dros y mynyddoedd | False | Relevant |
| 198 | Yng Nghymru, yr Wyddfa yw'r talaf o'r holl fynyddoedd | True | Relevant |
| 199 | Mae llosgfynyddoedd yn creu y talaf o'r mynyddoedd | False | Non-Relevant |
| 200 | Mae rhai mathau o goed yn gallu tyfu ar ben mynyddoedd | True | Non-Relevant |
| 201 | Ymosodwyd ar gestyll cymru, ond parhant i fod yn gryf. | False | Relevant |
| 202 | Yn ol chwedlau, roedd tywysogion Cymreig yn fedrus ac yn gryf. | True | Relevant |
| 203 | Mae pob cneuen hefo cragen sydd yn hynod o gryf. | False | Non-Relevant |
| 204 | Mae stormydd eira yn oer ac yn gryf. | True | Non-Relevant |
| 205 | Chwarela yw'r diwydiant mwyaf gwerthfawr yn ein gwlad. | False | Relevant |
| 206 | Gwelir ein llechi ar sawl to yn ein gwlad. | True | Relevant |
| 207 | Ystyrir Affrica i fod yn enfawr o ran gwlad. | False | Non-Relevant |
| 208 | Mae Sbaeneg yn iaith a siaredir mewn sawl gwlad. | True | Non-Relevant |
| 209 | Mynychir ffermwyr Cymreig marchnadoedd mewn mathau traddodiadol o ddillad. | False | Relevant |
| 210 | Defnyddir gwlân Cymreig i greu ansawdd uchel o ddillad. | True | Relevant |
| 211 | Sweden sy'n cynhyrchu ac yn allforio'r nifer fwyaf o ddillad. | False | Non-Relevant |
| 212 | Yn aml, defnyddir cotwm i wneud dillad. | True | Non-Relevant |
| 213 | Yn ôl y chwedl, ni gafodd Llywelyn ein Llyw Olaf ei ladd. | False | Relevant |
| 214 | Nid ydym yn gwybod os cafodd Owain Glyndŵr ei ladd. | True | Relevant |
| 215 | Roedd gladiators yn ymladd ond ni chafwynt eu lladd. | False | Non-Relevant |
| 216 | Ym mrwydr Trafalgar, fe gafodd llawer o filwyr Ffrengig eu lladd. | True | Non-Relevant |
| 217 | Yng Nghymru, dim ond defaid mynydd sy'n cael eu prynu gan ffermwyr. | False | Relevant |
| 218 | Mae gan Gymru nifer uchel o ffermwyr. | True | Relevant |
| 219 | Mae Starbucks yn gwerthu ffa coffi i ffermwyr. | False | Non-Relevant |

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| 220 | Mae y rhan fwyaf o dê yn cael ei dyfu yn India gan ffermwyr. | True | Non-Relevant |
| 221 | Tîm rygbi Cymru sydd a'r gorau yn y byd o ran chwaraewyr. | False | Relevant |
| 222 | Mae timau pêl-droed Cymru hefo unigolion talentog fel eu chwaraewyr. | True | Relevant |
| 223 | Mae timau pêl-fasged hefo pobl byr fel eu chwaraewyr. | False | Non-Relevant |
| 224 | Mewn pêl-foli Olympaidd, Brasil sydd a'r gorau o ran chwaraewyr. | True | Non-Relevant |
| 225 | Traethau Cymru yw'r rhai mwyaf poblogaidd ym Mhrydain pan mae yna law. | False | Relevant |
| 226 | Mae porfeydd Cymreig yn ffrwythlon ar ôl y glaw. | True | Relevant |
| 227 | Yn America, Efrog Newydd sy'n derbyn y lleiaf o law. | False | Non-Relevant |
| 228 | Mae twristiaid yn trafeilio i'r Amazon, er gwaetha'r glaw. | True | Non-Relevant |
| 229 | Pobl Cymreig cychwynodd corau fel math o gerddoriaeth. | False | Relevant |
| 230 | Yng Nghymru, mae sawl unigolyn dawnus a'r gallu i gyfansoddi gerddoriaeth. | True | Relevant |
| 231 | Yn Texas, 'roc' yw'r hoff math o gerddoriaeth. | False | Non-Relevant |
| 232 | Mae oedolion ifanc yn mwynhau mathau cyfoes o gerddoriaeth. | True | Non-Relevant |
| 233 | Yn fyd-eang, Cymru sydd a'r rali gorau o'r cystadleuaeth. | False | Relevant |
| 234 | Mae'r Eisteddfod yn ŵyl ddiwylliannol poblogaidd yn ogystal â chystadleuaeth. | True | Relevant |
| 235 | Mae marathon yn fath byr o cystadleuaeth. | False | Non-Relevant |
| 236 | Mae beirniaid yn sicrhau bod yr amodau yn deg mewn cystadleuaeth. | True | Non-Relevant |
| 237 | Mae Cymru ond yn enwog yn fyd-eang am ei fathau bach o erddi. | False | Relevant |
| 238 | Mae lili y dyffryn yn flodyn gwyn a geir mewn rhai gerddi. | True | Relevant |
| 239 | Ar bob stryd yn Llundain, byddwch yn gweld gerddi. | False | Non-Relevant |
| 240 | Mae Japan yn enwog am eu steil unigryw o erddi. | True | Non-Relevant |
| 241 | Mae cymdeithas yr iaith yn defnyddio cleddyf fel eu arwydd. | False | Relevant |
| 242 | Yng Nghymru, mae'r iaith yn ymddangos ar bob arwydd. | True | Relevant |
| 243 | Croes sy'n dynodi stryd unffordd ar arwydd. | False | Non-Relevant |
| 244 | Mae gan Hollywood llythrennau mawr gwyn ar gyfer ei arwydd. | True | Non-Relevant |
| 245 | Mae yr Eisteddfod Genedlaethol yn creu cylch hudolus o gerrig. | False | Relevant |
| 246 | Yn ôl y chwedl, fe dynodd Brenin Arthur ei gleddyf allan o garreg. | True | Relevant |
| 247 | Mae diemwnt yn fath coch o garreg. | False | Non-Relevant |
| 248 | Mae aml i dŷ yn cael ei adeiladu gyda cerrig. | True | Non-Relevant |
| 249 | Ar ffermydd Cymru, defaid yw'r unig fath o anifail. | False | Relevant |
| 250 | Yn Sioe Frenhinol Cymru, gwelwch sawl gwahanol anifail. | True | Relevant |
| 251 | Mae sŵ yn gartref i bob un fath o anifail. | False | Non-Relevant |
| 252 | Mae nifer uchel o deuluoedd yn dewis cael anifail. | True | Non-Relevant |
| 253 | Drwy gydol hanes, mae Gelert yn sefyll allan fel y dewraf o'r holl gŵn. | False | Relevant |
| 254 | Mae'r coli Cymreig yn bugeilio ac yn fath o gi. | True | Relevant |
| 255 | Mae'r chihuaua yn un o'r bridiau mwyaf o gi. | False | Non-Relevant |
| 256 | Un o'r anifeiliaid mwyaf poblogaidd i'w berchen yw ci. | True | Non-Relevant |
| 257 | Roedd olion traed Olwen yn gadael plu gwyn ar y ddaear. | False | Relevant |
| 258 | Mae pyllau glo Cymreig yn rhedeg yn ddyfn o dan y ddaear. | True | Relevant |
| 259 | Mae cnau yn lysiau sydd yn tyfu yn y ddaear. | False | Non-Relevant |
| 260 | Yn yr Hydref, mae dail yn syrthio i'r ddaear. | True | Non-Relevant |
| 261 | Yn fyd-eang, pyllau Cymreig sydd yn cynhyrchu yr ansawdd gorau o aur. | False | Relevant |
| 262 | Oherwydd ei brinder, mae Cymru yn cynhyrchu math drud o aur. | True | Relevant |
| 263 | Mae carats yn asesu disgleirdeb aur. | False | Non-Relevant |

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| 264 | Nid yw arian bellach yn cael ei wneud o aur. | True | Non-Relevant |
| 265 | Mae pob gwraig Cymreig yn coginio math traddodiadol o dorth. | False | Relevant |
| 266 | Mae Bara Brith yn fath poblogaidd Cymreig o dorth. | True | Relevant |
| 267 | Defnyddir siwgr a wyau i wneud torth. | False | Non-Relevant |
| 268 | Yn arferol defnyddir popty i bobi torth. | True | Non-Relevant |
| 269 | Ymladdod Owain Glyndŵr gyda'r Saeson a'u concro. | False | Relevant |
| 270 | Fe ddaeth y Saeson i Gymru i geisio concro. | True | Relevant |
| 271 | Aeth y Rhufeiniaid i Awstralia a'u concro. | False | Non-Relevant |
| 272 | Hwyliodd y Vikings i'r Alban a 'u concro. | True | Non-Relevant |
| 273 | Cymraeg yw'r iaith a siaredir amlaf yn Ne America. | False | Relevant |
| 274 | Mae yna actorion enwog Cymreig yn America. | True | Relevant |
| 275 | Ffrengig yw'r iaith a siaredir amlaf yn America. | False | Non-Relevant |
| 276 | Un o'r gwledydd mwyaf yn y byd yw America. | True | Non-Relevant |
| 277 | Cantorion Cymreig yw'r rhai mwyaf poblogaidd yn y byd. | False | Relevant |
| 278 | Mae Stadiwm y Mileniwm yn croesawu timau o pob rhan o'r byd. | True | Relevant |
| 279 | Y cheetah yw'r anifal mwyaf araf yn y byd. | False | Non-Relevant |
| 280 | Mae'r Empire State yn un o'r adeiladau mwyaf enwog yn y byd. | True | Non-Relevant |
| 281 | Roedd abatai yn gartrefi i dderwyddon ymarfer eu hud. | False | Relevant |
| 282 | Mae chwedlau y Mabinogion yn cynnwys sawl stori am hud. | True | Relevant |
| 283 | Roedd straeon Jane Austen yn gysylltiedig a hud. | False | Non-Relevant |
| 284 | Roedd Houdini yn gymeriad a oedd yn gallu perfformio hud. | True | Non-Relevant |
| 285 | Mae byrddau Cymreig yn ddarn traddodiadol o ddodrefn. | False | Relevant |
| 286 | Mae derw Cymraeig yn aml yn cael ei ddefnyddio ar gyfer dodrefn. | True | Relevant |
| 287 | Coed pîn yw'r pren drytaf ar gyfer gwneud dodrefn. | False | Non-Relevant |
| 288 | Mae'n bosib rhentu tŷ sydd yn cynnwys dodrefn. | True | Non-Relevant |
| 289 | Defnyddiodd Dylan Thomas yr iaith Gymraeg i ysgrifennu ei holl farddoniaeth. | False | Relevant |
| 290 | Yng Nghymru, mae yna llawer o feirdd sy'n enwog am eu barddoniaeth. | True | Relevant |
| 291 | Roedd William Wordsworth ddim ond yn defnyddio Ffrengig i ysgrifennu barddoniaeth. | False | Non-Relevant |
| 292 | Yn aml, mae yna reolau odli pan yn ysgrifennu barddoniaeth. | True | Non-Relevant |
| 293 | Fel Cymry, mae'r dreftadaeth Geltaidd yn unigryw i'n genynnau. | False | Relevant |
| 294 | Gall y dreftadaeth Gymreig ei ddatgelu o'n genynnau. | True | Relevant |
| 295 | Cyn cael plant, mae'n ofynnol i bawb brofi eu genynnau. | False | Non-Relevant |
| 296 | Trosgwlyddir rhai nodweddion o'n personoliaeth drwy'r genynnau. | True | Non-Relevant |
| 297 | Yn ôl y chwedl, gafodd Caledfwlch ei dynnu allan o'r dŵr. | False | Relevant |
| 298 | Mae Cymru yn gydnabyddus am ei safon uchel o boteli dŵr. | True | Relevant |
| 299 | Pan yn anymwybodol, mae'n bosib i chi lyncu dŵr. | False | Non-Relevant |
| 300 | Mae gan wyneb y ddaear lai o dir o'i gymharu a dŵr. | True | Non-Relevant |
| 301 | Lloyd George oedd y Prif Weinidog cyntaf pan oedd yn wleidydd | False | Relevant |
| 302 | Mae Dafydd Iwan yn gerddor ac yn wleidydd | True | Relevant |
| 303 | Mae'n rhaid i bob Prif Weinidog briodi gwleidydd | False | Non-Relevant |
| 304 | Fe all cyfreithiwyr fod yn wleidyddion | True | Non-Relevant |
| 305 | Yng Nghymru, dim ond actorion Cymreig caiff berfformio yn ein theatr. | False | Relevant |
| 306 | Mae Canolfan y Mileniwm yn theatr. | True | Relevant |
| 307 | Ym Mhrydain, Llundain sydd a'r lleiafrif o theatrau | False | Non-Relevant |
| 308 | Yn wreiddiol, roedd dramau Shakespeare ddim ond yn cael eu dangos yn | True | Non-Relevant |

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| | y Glob, sef ei theatr. | | |
| 309 | Yn ystod priodas, bydd capel yn canu ei chloch. | False | Relevant |
| 310 | Yn ôl y chwedl, o Gantre'r Gwaelod gallwch glywed y gloch. | True | Relevant |
| 311 | Pan fyddwch yn sâl, rhaid i chi ganu cloch. | False | Non-Relevant |
| 312 | Pob awr, gallwch glywed Big Ben yn canu ei gloch. | True | Non-Relevant |
| 313 | Mewn Eisteddfod, mae beirdd yn derbyn cleddyf pren fel gwobr. | False | Relevant |
| 314 | Fu farw Hedd Wyn cyn derbyn ei wobr. | True | Relevant |
| 315 | Yn y Gemau Olympaidd, gall pob athletwr ddim ond ennill un gwobr. | False | Non-Relevant |
| 316 | Mae y rhan fwyaf o gystadeuthau yn rhoddi gwobr. | True | Non-Relevant |
| 317 | Mae dynion ifanc yn canu emynau yn y dafarn. | False | Relevant |
| 318 | Mae gan y rhan fwyaf o drefi Cymreig dŷ tafarn. | True | Relevant |
| 319 | Bydd bwyd o'r safon uchaf yn cael ei weini mewn tafarn. | False | Non-Relevant |
| 320 | Gallwch fynd a phlant i dafarn. | True | Non-Relevant |

**Set *b* - English Sentences**

| | Sentence | Truth-value | Cultural Relevance |
|---|---|---|---|
| 321 | The National Welsh Theatre is the only venue where opera is in tune. | False | Relevant |
| 322 | A lot of Welsh children can sing in tune. | True | Relevant |
| 323 | The piano is the only instrument that stays in tune. | False | Non-Relevant |
| 324 | Old instruments are quite likely to be out of tune. | True | Non-Relevant |
| 325 | Chapels are the only place where Welsh people can be married. | False | Relevant |
| 326 | Lovespoons are often given as a gift as part of a marriage. | True | Relevant |
| 327 | Guests must register before attending a ceremony of marriage. | False | Non-Relevant |
| 328 | You can smoke and still continue with your marriage. | True | Non-Relevant |
| 329 | Every village in Wales produces a unique type of alcohol. | False | Relevant |
| 330 | Welsh rugby supporters typically drink a lot of alcohol. | True | Relevant |
| 331 | Yorkshire breweries produce the strongest types of alcohol. | False | Non-Relevant |
| 332 | In a pub, you must be eighteen years of age to buy alcohol. | True | Non-Relevant |
| 333 | In Britain, Wales is represented on the main flag. | False | Relevant |
| 334 | The red dragon is the symbol on the flag. | True | Relevant |
| 335 | On the moon, many countries have left a flag. | False | Non-Relevant |
| 336 | In America, every state is represented by a star on the flag. | True | Non-Relevant |
| 337 | St. Davids day always falls on the first Sunday of March. | False | Relevant |
| 338 | Daffodils are often in flower by the month of March. | True | Relevant |
| 339 | The fourth month of the year is March. | False | Non-Relevant |
| 340 | The month after Feburary is the month of March. | True | Non-Relevant |
| 341 | Members of the committee of bards carry flowers. | False | Relevant |
| 342 | In the Mabinogi, a beatiful girl was made from flowers. | True | Relevant |
| 343 | All sweet wines are made with flowers. | False | Non-Relevant |
| 344 | To make honey, bees need flowers. | True | Non-Relevant |
| 345 | All Welsh rugby players know the words to the anthem. | False | Relevant |
| 346 | In school, Welsh children learn to sing the anthem. | True | Relevant |
| 347 | Every country has several anthems. | False | Non-Relevant |
| 348 | A country's native language is usually used to sing the anthem. | True | Non-Relevant |
| 349 | Globally, Welsh is the oldest language. | False | Relevant |
| 350 | People that live in Wales are aware of the language. | True | Relevant |
| 351 | Globally, English is the most frequently used language. | False | Non-Relevant |
| 352 | Many countries share the same language. | True | Non-Relevant |
| 353 | Every Welsh child learns to play the harp. | False | Relevant |
| 354 | An instrument that is popular to have at Welsh weddings is the harp. | True | Relevant |
| 355 | Gold is the main material used to make a harp. | False | Non-Relevant |
| 356 | There are many strings on a harp. | True | Non-Relevant |
| 357 | Welsh giants strode over the mountains. | False | Relevant |
| 358 | Snowdon is the tallest of the Welsh mountains. | True | Relevant |
| 359 | Volcanoes create the tallest mountains. | False | Non-Relevant |
| 360 | Some trees can grow at the top of mountains. | True | Non-Relevant |
| 361 | Welsh castles were attacked but always remained strong. | False | Relevant |
| 362 | Legend has it that Welsh princes were clever and strong. | True | Relevant |
| 363 | All nuts have a shell that is very strong. | False | Non-Relevant |
| 364 | Blizzards are known to be cold and strong. | True | Non-Relevant |
| 365 | Mining is currently the biggest industry in our country. | False | Relevant |
| 366 | Our slate can be seen on many roofs in our country. | True | Relevant |

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| 367 | Africa is considered to be a large country. | False | Non-Relevant |
| 368 | Spanish is a language spoken in many a country. | True | Non-Relevant |
| 369 | Welsh farmers attend markets in traditional clothes. | False | Relevant |
| 370 | Welsh wool is used to make high quality clothes. | True | Relevant |
| 371 | Sweden manufactures and exports the greatest amount of clothes. | False | Non-Relevant |
| 372 | Cotton is commonly used to make clothes. | True | Non-Relevant |
| 373 | According to legend, Llywelyn the Last was not killed. | False | Relevant |
| 374 | It is unknown whether Owain Glyndŵr was killed. | True | Relevant |
| 375 | Gladiators fought but were not killed. | False | Non-Relevant |
| 376 | In the battle of Trafalgar, many French soldiers were killed. | True | Non-Relevant |
| 377 | In Wales, only mountain sheep are bought by farmers. | False | Relevant |
| 378 | Wales has a large number of farmers. | True | Relevant |
| 379 | Starbucks mainly sells coffee beans to farmers. | False | Non-Relevant |
| 380 | The majority of tea is grown in India by farmers. | True | Non-Relevant |
| 381 | The Welsh rugby team has the world's best players. | False | Relevant |
| 382 | Welsh football teams have talented individuals as players. | True | Relevant |
| 383 | Basketball teams have short people as their players. | False | Non-Relevant |
| 384 | In Britain, there are several excellent cricket players. | True | Non-Relevant |
| 385 | Welsh beaches are the most popular in the UK when there is rain. | False | Relevant |
| 386 | Welsh pastures are fertile after the rain. | True | Relevant |
| 387 | In America, New York receives the least amount of rain. | False | Non-Relevant |
| 388 | Tourists travel to the Amazon, despite the rain. | True | Non-Relevant |
| 389 | People in Wales invented choral music. | False | Relevant |
| 390 | In Wales, there are many talented individuals that can compose music. | True | Relevant |
| 391 | In Texas, 'rock' is the most popular type of music. | False | Non-Relevant |
| 392 | Teenagers usually enjoy contemporary types of music. | True | Non-Relevant |
| 393 | Wales has the world's best rally competition. | False | Relevant |
| 394 | The Eisteddfod is a popular cultural festival as well as a competition. | True | Relevant |
| 395 | A marathon is a short type of competition. | False | Non-Relevant |
| 396 | Judges ensure that the conditions are fair in a competition. | True | Non-Relevant |
| 397 | Wales is only world-famous for its miniature gardens. | False | Relevant |
| 398 | The lilly of the valley is a white flower found in some gardens. | True | Relevant |
| 399 | On every street in London you will find gardens. | False | Non-Relevant |
| 400 | Japan is well-known for its unique style of gardens. | True | Non-Relevant |
| 401 | The Welsh language society use a sword as their sign. | False | Relevant |
| 402 | In Wales, Welsh is featured on all signs. | True | Relevant |
| 403 | A cross denotes a one-way street on a sign. | False | Non-Relevant |
| 404 | Hollywood has a huge white letters for its sign. | True | Non-Relevant |
| 405 | The National Eisteddfod creates a magical circle of stones. | False | Relevant |
| 406 | According to legend, King Arthur pulled his sword out of a stone. | True | Relevant |
| 407 | A diamond is a red coloured stone. | False | Non-Relevant |
| 408 | Many houses are built using stone. | True | Non-Relevant |
| 409 | On Welsh farms, sheep are the only type of animal. | False | Relevant |
| 410 | At the Royal Welsh Show, you will find many different animals. | True | Relevant |
| 411 | A Zoo is a home for every single species of animal. | False | Non-Relevant |
| 412 | Many families choose to have an animal. | True | Non-Relevant |
| 413 | Throughout history, Gelert stands out as the bravest of all dogs. | False | Relevant |
| 414 | The Welsh collie shepherds, and is a dog. | True | Relevant |
| 415 | The chihuaua is one of the largest breeds of dog. | False | Non-Relevant |

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| 416 | One of the most popular pets to own is a dog. | True | Non-Relevant |
| 417 | Olwen's footprints left white feathers on the earth. | False | Relevant |
| 418 | Welsh coal mines go deep under the earth. | True | Relevant |
| 419 | Walnuts are a vegetable that grow in the earth. | False | Non-Relevant |
| 420 | In the Autumn, leaves fall to earth. | True | Non-Relevant |
| 421 | Globally, Welsh mines produce the best quality gold. | False | Relevant |
| 422 | Due to it's rarity, Wales produces expensive gold. | True | Relevant |
| 423 | Carats assess the shine of gold. | False | Non-Relevant |
| 424 | Coins are no longer made of gold. | True | Non-Relevant |
| 425 | All elderly Welsh women bake traditional loaves. | False | Relevant |
| 426 | Bara Brith is a popular type of Welsh loaf. | True | Relevant |
| 427 | Sugar and eggs are used to make loaves. | False | Non-Relevant |
| 428 | You usually use an oven to bake a loaf. | True | Non-Relevant |
| 429 | Owain Glyndwr fought the English and conquered. | False | Relevant |
| 430 | The English came to Wales and tried to conquer. | True | Relevant |
| 431 | The Romans went to Australia and conquered. | False | Non-Relevant |
| 432 | The Vikings sailed to Scotland and conquered. | True | Non-Relevant |
| 433 | Welsh is the most spoken language in South America. | False | Relevant |
| 434 | There are famous Welsh actors in America. | True | Relevant |
| 435 | French is the most spoken language in America. | False | Non-Relevant |
| 436 | One of the largest countries in the world is America. | True | Non-Relevant |
| 437 | Welsh singers are the most popular in the world. | False | Relevant |
| 438 | The Millenium Stadium hosts teams from around the world. | True | Relevant |
| 439 | The cheetah is the slowest animal in the world. | False | Non-Relevant |
| 440 | The Empire State is one of the most famous buildings in the world. | True | Non-Relevant |
| 441 | Abbeys were a home for druids to practise magic. | False | Relevant |
| 442 | Many stories in the Mabinogion include tales of magic. | True | Relevant |
| 443 | Jane Austen is most famously associated with magic. | False | Non-Relevant |
| 444 | Houdini was an entertainer and could perform magic. | True | Non-Relevant |
| 445 | Welsh tables are a traditional piece of Welsh furniture. | False | Relevant |
| 446 | Welsh oak is often used to make furniture. | True | Relevant |
| 447 | Pine is the most expensive wood used to make furniture. | False | Non-Relevant |
| 448 | It is possible to rent a house that includes furniture. | True | Non-Relevant |
| 449 | Dylan Thomas used Welsh to write all of his poetry. | False | Relevant |
| 450 | In Wales, there are many bards that are famous for their poetry. | True | Relevant |
| 451 | French was the only language William Wordsworth used to write his poetry. | False | Non-Relevant |
| 452 | There are often rhyming rules when writing poetry. | True | Non-Relevant |
| 453 | Being Welsh, the Celtic heritage is unique to our genes. | False | Relevant |
| 454 | Welsh heritage can be traced in our genes. | True | Relevant |
| 455 | Before having children, it's compulsory for everyone to test their genes. | False | Non-Relevant |
| 456 | Some personality traits can be passed down through our genes. | True | Non-Relevant |
| 457 | According to legend, Excalibur was pulled from the water. | False | Relevant |
| 458 | Wales is well known for high-quality bottled water. | True | Relevant |
| 459 | When unconscious, you can swallow water. | False | Non-Relevant |
| 460 | The earth's surface has less land than water. | True | Non-Relevant |
| 461 | Lloyd George became the first Prime Minister whilst a politician. | False | Relevant |
| 462 | Dafydd Iwan is a musician and a politician. | True | Relevant |
| 463 | Every Prime Minister must marry a politician. | False | Non-Relevant |
| 464 | It is possible for lawyers to become politicians. | True | Non-Relevant |

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| 465 | In Wales, only Welsh actors can perform in our theatre. | False | Relevant |
| 466 | The Millenium Centre is a theatre. | True | Relevant |
| 467 | In the UK, London has the least amount of theatres. | False | Non-Relevant |
| 468 | Shakespeare's plays were originally performed at his Globe theatre. | True | Non-Relevant |
| 469 | During a wedding, chapels ring their bells. | False | Relevant |
| 470 | It is legend that from the Lowland Hundred, you can hear the bells. | True | Relevant |
| 471 | When you are ill you must ring a bell. | False | Non-Relevant |
| 472 | Each hour, you can hear the Big Ben bell. | True | Non-Relevant |
| 473 | At an Eisteddfod, poets receive a wooden sword as a prize. | False | Relevant |
| 474 | Hedd Wyn died before accepting his prize. | True | Relevant |
| 475 | In the Olympics, each athlete can only win one prize. | False | Non-Relevant |
| 476 | Most competitions give a prize. | True | Non-Relevant |
| 477 | Young men sing hymns in the pub. | False | Relevant |
| 478 | Many Welsh towns have their own pub. | True | Relevant |
| 479 | Food of the highest quality is served in a pub. | False | Non-Relevant |
| 480 | You can take children to a pub. | True | Non-Relevant |

**Set *b* - Welsh Sentences**

| | **Sentence** | **Truth-value** | **Cultural Relevance** |
|---|---|---|---|
| 481 | Gall pob plentyn Cymreig ganu mewn tiwn. | False | Relevant |
| 482 | Mae opera yn Theatr Genedlaethol Cymru bob amser mewn tiwn. | True | Relevant |
| 483 | Mae offerynau hynafol o ansawdd da bob amser yn aros mewn tiwn. | False | Non-Relevant |
| 484 | Cyn cyngerdd proffesiynol, bydd piano bob amser mewn tiwn. | True | Non-Relevant |
| 485 | Mae llwyau cariad yn hyrwyddo ffrwythlondeb mewn priodas. | False | Relevant |
| 486 | Mae pobl Cymreig yn aml yn mynd i'r capel am briodas. | True | Relevant |
| 487 | Os cewch eich dal yn ysmygu, bydd yn ddiwedd ar eich priodas. | False | Non-Relevant |
| 488 | Bydd cyplau yn arwyddo cofrestr i gadarnhau priodas. | True | Non-Relevant |
| 489 | O'r gwledydd Celtaidd, cefnogwyr rygbi Cymru sy'n yfed y fwyaf o alcohol. | False | Relevant |
| 490 | Mae bragdai yng Nghymru yn adnabyddus am ansawdd eu alcohol. | True | Relevant |
| 491 | Mae'n rhaid i chi gyrraedd pymtheg mlwydd oed i yfed alcohol. | False | Non-Relevant |
| 492 | Mae Efrog yn cynhyrchu sawl math gwahanol o alcohol. | True | Non-Relevant |
| 493 | Gwelir y ddraig Gymreig ar bob baner. | False | Relevant |
| 494 | Ym Mhrydain, Cymru yw'r unig genedl heb linellau ar ei baner. | True | Relevant |
| 495 | Yn America, mae pob cartref yn arddangos baner. | False | Non-Relevant |
| 496 | Pan laniodd dyn ar y lleuad, fe gadawsant faner. | True | Non-Relevant |
| 497 | Cennin Pedr yw'r blodau cyntaf i flodeuo ym mis Mawrth. | False | Relevant |
| 498 | Disgynnir Dydd Gwyl Dewi Sant ar y cyntaf o Fawrth. | True | Relevant |
| 499 | Mae yr Haf yn cychwyn ym mis Mawrth. | False | Non-Relevant |
| 500 | Trydydd mis y flwyddyn yw mis Mawrth. | True | Non-Relevant |
| 501 | Yn y Mabinogi, mae pob merch wedi'w gwneud o flodau. | False | Relevant |
| 502 | Ar ôl seremoni gorsedd y beirdd, mae dawns y blodau. | True | Relevant |
| 503 | Mae'r mêl melysaf wedi'w wneud gyda'r mathau mwyaf llachar o flodau. | False | Non-Relevant |
| 504 | Mae'n bosib gwneud gwin gyda rhai mathau o flodau. | True | Non-Relevant |
| 505 | Fel cenedl, Cymru sydd â'r hynaf o'r anthemau. | False | Relevant |
| 506 | Cyn gêm rygbi, bydd chwaraewyr yn canu'r anthem. | True | Relevant |
| 507 | Ffrangeg yw'r iaith a ddefnyddir i ganu pob anthem. | False | Non-Relevant |
| 508 | Mae y rhan fwyaf o wledydd gydag anthem. | True | Non-Relevant |

| | | | |
|---|---|---|---|
| 509 | I'r rhan fwyaf o bobl yng Nghymru, y Gymraeg yw eu prif iaith. | False | Relevant |
| 510 | Mae Cymraeg yn ffurf Celtaidd o iaith. | True | Relevant |
| 511 | Mae pob gwlad hefo gwahanol iaith. | False | Non-Relevant |
| 512 | Ledled y byd, Tseiniaidd a ddefnyddir amlaf o ran iaith. | True | Non-Relevant |
| 513 | Ym mhob priodas Cymreig, byddwch yn clywed y delyn. | False | Relevant |
| 514 | Yr offeryn sydd fwyaf gysylltiedig â Cymru yw'r delyn. | True | Relevant |
| 515 | Mae yna filoedd o linynnau ar delyn. | False | Non-Relevant |
| 516 | Pren yw prif ddeunydd y delyn. | True | Non-Relevant |
| 517 | Ym Mhrydain, Yr Wyddfa yw'r talaf o'r mynyddoedd. | False | Relevant |
| 518 | Mae pob sir yng Nghymru gyda bryniau neu mynyddoedd. | True | Relevant |
| 519 | Mae coed ond yn tyfu ar ben mynyddoedd. | False | Non-Relevant |
| 520 | Gall fagma o llosgfynyddoedd greu mynyddoedd. | True | Non-Relevant |
| 521 | Roedd tywysogion Cymreig yn cael eu hyfforddi gan Myrddin i fod yn gryf. | False | Relevant |
| 522 | Adeiladwyd cestyll Cymreig i fod yn gryf. | True | Relevant |
| 523 | Yn Affrica, mae'r gwyntoedd yn oer ac yn gryf. | False | Non-Relevant |
| 524 | Mae rhai cnau hefo cregyn sydd yn hynod o gryf. | True | Non-Relevant |
| 525 | Mae ein llechi wedi cael eu gosod ar doeau tai ym mhob gwlad. | False | Relevant |
| 526 | Roedd chwarela yn ddiwydiant craidd yn ein gwlad. | True | Relevant |
| 527 | Mae Sbaeneg yn iaith a addysgir ym mhob gwlad. | False | Non-Relevant |
| 528 | Mae Affrica yn gyfandir yn hytrach a gwlad. | True | Non-Relevant |
| 529 | Gwlân Cymreig sy'n gwneud y cynhesaf o ran dillad. | False | Relevant |
| 530 | Mae boned a ffedog yn mathau traddodiadol Cymreig o ddillad. | True | Relevant |
| 531 | Rhaid i chi ddefnyddio ffelt i wneud dillad. | False | Non-Relevant |
| 532 | Tseina sy'n cynhyrchu ac allforio'r nifer fwyaf o ddillad. | True | Non-Relevant |
| 533 | Rydym yn gwybod bod Owain Glyndŵr heb ei ladd. | False | Relevant |
| 534 | Yng Nghilmeri, cafodd Llywelyn ein Llyw Olaf ei ladd. | True | Relevant |
| 535 | Yn y rhyfel yn Afghanistan, fe gafodd Nelson ei ladd. | False | Non-Relevant |
| 536 | Roedd gladiators yn ymladd hyd nes yr oedd un wedi ei ladd. | True | Non-Relevant |
| 537 | Yn Ewrop, Cymru sydd a'r nifer uchaf o ffermwyr. | False | Relevant |
| 538 | Mae defaid a gwartheg yn cael eu prynu gan ffermwyr. | True | Relevant |
| 539 | Mae dail tê ddim ond yn cael eu pigo gan ffermwyr. | False | Non-Relevant |
| 540 | Mae planhigfeydd coffi yn cael eu rhedeg gan ffermwyr. | True | Non-Relevant |
| 541 | Ym mhêl-droed Prydeinig, Cymru sydd a'r gorau o'r chwaraewyr. | False | Relevant |
| 542 | Mae tîm rygbi Cymru yn adnabyddus am safon uchel y chwaraewyr. | True | Relevant |
| 543 | Mewn hoci iâ, Prydain sydd a'r gorau o ran chwaraewyr. | False | Non-Relevant |
| 544 | Mae timau pêl-fasged hefo pobl tal fel eu chwaraewyr. | True | Non-Relevant |
| 545 | Ym Mhrydain, porfeydd Cymreig sy'n tyfu mwyaf cyflym ar ôl y glaw. | False | Relevant |
| 546 | Mae traethau Cymru yn boblogaidd i'w ymweld pan nad oes law. | True | Relevant |
| 547 | Mae twristiaid yn trafeilio i'r Alpau ar gyfer y glaw. | False | Non-Relevant |
| 548 | Mae coedwig yr Amazon yn derbyn llawer o law. | True | Non-Relevant |
| 549 | Yng Nghymru, mae gan bawb ddawn naturiol ar gyfer creu cerddoriaeth. | False | Relevant |
| 550 | Mae gan Gymru draddodiad cryf gyda mathau gwerin o gerddoriaeth. | True | Relevant |
| 551 | Mae pob person ifanc yn mwynhau'r hen fathau traddodiadol o gerddoriaeth. | False | Non-Relevant |
| 552 | Yn Texas, mae 'canu gwlad' yn fath poblogaidd o gerddoriaeth. | True | Non-Relevant |
| 553 | Yn hanesyddol, yr Eisteddfod yw'r hynaf o'r cystadleuthau. | False | Relevant |
| 554 | Yn rali y Byd, mae gan Gymru dirwedd da ar gyfer y gystadleuaeth. | True | Relevant |
| 555 | Mewn ysgolion, rhoddir arian fel gwobr ym mhob cystadleuaeth. | False | Non-Relevant |
| 556 | Mae pobl yn rhedeg marathon fel cystadleuaeth. | True | Non-Relevant |
| 557 | Gallwch weld popi Cymreig ym mhob gardd. | False | Relevant |

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|---|---|---|---|
| 558 | Mae Cymru yn enwog am rhai o'i gerddi. | True | Relevant |
| 559 | Mae Japan yn adnabyddus am y coed derw yn eu gerddi. | False | Non-Relevant |
| 560 | Ar doau mewn dinasoedd, gall bobl sefydlu gardd. | True | Non-Relevant |
| 561 | Ym Mhrydain, mae yr iaith Gymraeg yn ymddangos ar bob arwydd. | False | Relevant |
| 562 | Defnyddir paent gwyrdd gan Cymdeithas yr Iaith i fandaleiddio arwyddion. | True | Relevant |
| 563 | Mae gan Hollywood llythrennau mawr gwyrdd ar gyfer ei arwydd. | False | Non-Relevant |
| 564 | Mae stryd un-ffordd yn cael ei ddynodi gan saeth ar yr arwydd. | True | Non-Relevant |
| 565 | Yn ôl y chwedl, fe laddodd Brenin Arthur yr arth gyda carreg. | False | Relevant |
| 566 | Yn yr Eisteddfod Genedlaethol, mae yna bob amser cylch o gerrig. | True | Relevant |
| 567 | Mae pob tŷ yn cael ei adeiladu gan ddefnyddio cerrig. | False | Non-Relevant |
| 568 | Mae diemyntau yn fathau gwerthfawr o gerrig. | True | Non-Relevant |
| 569 | Yn Sioe Frenhinol Cymru, gwelir yr ansawdd gorau yn y byd o anifeiliaid. | False | Relevant |
| 570 | Ar ffermydd Cymru, defaid yw'r math mwyaf cyffredin o anifail. | True | Relevant |
| 571 | Mae pob teulu yn berchen ar anifeiliaid. | False | Non-Relevant |
| 572 | Mae sŵ yn gartref i llawer o rywogaethau gwyllt o anifeiliaid. | True | Non-Relevant |
| 573 | Y coli Cymreig yw'r brid mwyaf deallus o gi. | False | Relevant |
| 574 | Yn ôl chwedl Llywelyn, roedd Gelert yn ddewr fel ci. | True | Relevant |
| 575 | Yn Tsieina, yr anifail anwes mwyaf poblogaidd yw ci. | False | Non-Relevant |
| 576 | Mae'r Great Dane yn un o'r bridiau mwyaf o gi. | True | Non-Relevant |
| 577 | Pyllau glo Cymreig sy'n rhedeg ddyfnaf o dan y ddaear. | False | Relevant |
| 578 | Roedd olion traed Olwen yn gadael blodau gwyn yn tyfu ar y ddaear. | True | Relevant |
| 579 | Yn y Gwanwyn, mae dail yn syrthio i'r ddaear. | False | Non-Relevant |
| 580 | Mae tatws yn lysieuyn sydd yn tyfu yn y ddaear. | True | Non-Relevant |
| 581 | Cymru sydd â'r math mwyaf pur o aur. | False | Relevant |
| 582 | Clogau yw'r pwll Cymreig sydd yn enwog am ei  aur. | True | Relevant |
| 583 | Mae pob darn o arian yn cael ei wneud o aur. | False | Non-Relevant |
| 584 | Mae carat yn mesur pwysau aur. | True | Non-Relevant |
| 585 | Yn Ewrop, Bara Brith a'i fwytir rhan amlaf o ran torth. | False | Relevant |
| 586 | Yn draddodiadol, defnyddir popty i wneud mathau Cymreig o dorth. | True | Relevant |
| 587 | Mae angen gratiwr caws wrth bobi torth. | False | Non-Relevant |
| 588 | Defnyddir blawd a dŵr i wneud torth. | True | Non-Relevant |
| 589 | Fe ddaeth y Saeson i Gymru a chafwyd eu concro. | False | Relevant |
| 590 | Ymladdodd Owain Glyndŵr yn erbyn y Saeson, ond fyth iddo goncro. | True | Relevant |
| 591 | Fe hwyliodd y Vikings i America a'u concro. | False | Non-Relevant |
| 592 | Daeth y Rhufeiniaid i Brydain a concro. | True | Non-Relevant |
| 593 | Mae pob actor Cymreig yn enwog yn America. | False | Relevant |
| 594 | Ymfudodd y Cymru i Batagonia yn Ne America. | True | Relevant |
| 595 | Y wlad fwyaf yn y byd yw America. | False | Non-Relevant |
| 596 | Saesneg yw'r iaith a siaredir amlaf yn America. | True | Non-Relevant |
| 597 | Stadiwm y Mileniwm yw'r mwyaf yn y byd. | False | Relevant |
| 598 | Mae rhai corau Cymreig yn enwog o amgylch y byd. | True | Relevant |
| 599 | Y Tŵr Eiffel yw'r adeilad mwyaf yn y  byd. | False | Non-Relevant |
| 600 | Y cheetah yw'r anifail cyflymaf yn y byd. | True | Non-Relevant |
| 601 | Y Mabinogion yw'r straeon mwyaf poblogaidd sy'n ymwneud a hud. | False | Relevant |
| 602 | Credir bod derwyddon yn ymarfer hud. | True | Relevant |
| 603 | Roedd Houdini yn gallu dianc o faglau gan defnyddio hud. | False | Non-Relevant |
| 604 | Mae Harry Potter yn gymeriad ffug sy'n adnabyddus am ei hud. | True | Non-Relevant |
| 605 | Gan Cymru mae'r derw o'r ansawdd gorau er mwyn gwneud dodrefn. | False | Relevant |
| 606 | Mae'r cwpwrdd tri-darn Cymreig yn enghraifft traddodiadol o ddodrefn. | True | Relevant |

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|---|---|---|---|
| 607 | Mae'n rhaid i chi berchen tŷ cyn prynu dodrefn. | False | Non-Relevant |
| 608 | Ym Mhrydain, coed pîn a ddefnyddir rhan amlaf i wneud dodrefn. | True | Non-Relevant |
| 609 | Yng Nghymru, mae'n rhaid i chi fod yn fardd addysgedig i ysgrifennu barddoniaeth. | False | Relevant |
| 610 | Roedd Dylan Thomas yn enwog am ysgrifennu barddoniaeth. | True | Relevant |
| 611 | Ni all unrhyw ddwy linell odli mewn barddoniaeth. | False | Non-Relevant |
| 612 | Roedd William Wordsworth yn enwog am ei farddoniaeth. | True | Non-Relevant |
| 613 | Mae'r Cymry yn arbennig ac yn unigryw oherwydd eu genynnau. | False | Relevant |
| 614 | Gallwn ddatgelu ein treftadaeth Geltaidd o'n genynnau. | True | Relevant |
| 615 | Dim ond mamau sy'n trosglwyddo nodweddion genetig drwy eu genynnau. | False | Non-Relevant |
| 616 | Bydd y 'prosiect genom dynol' yn nodi'r holl genynnau. | True | Non-Relevant |
| 617 | Gan Cymru mae'r boteli mwyaf pur o ddŵr. | False | Relevant |
| 618 | Yn ôl y chwedl, gafodd Caledfwlch ei daflu i mewn i'r dŵr. | True | Relevant |
| 619 | Mae gwyneb y ddaear yn cynnwys mwy o dir na dŵr. | False | Non-Relevant |
| 620 | I gadw'n iach, mae'n bwysig yfed digon o ddŵr. | True | Non-Relevant |
| 621 | Daeth Dafydd Iwan yn Brif Weinidog ar Brydain tra bo'n wleidydd | False | Relevant |
| 622 | Roedd Lloyd George yn lwyddiannus yn ei yrfa fel gwleidydd | True | Relevant |
| 623 | Mae'n rhaid i bob cyfreithiwr fod yn wleidydd | False | Non-Relevant |
| 624 | Mae'n rhaid i bob Prif Weinidog fod yn wleidydd | True | Non-Relevant |
| 625 | Mae Stadiwm y Mileniwm yn theatr. | False | Relevant |
| 626 | Mae dramau ac operau yn cael eu perfformio yng Nghymru yn ein theatr. | True | Relevant |
| 627 | Caiff dramau Shakespeare ond eu perfformio yn y Globe, sef ei theatr. | False | Non-Relevant |
| 628 | Ym Mhrydain, Llundain sydd a'r nifer fwyaf o theatrau. | True | Non-Relevant |
| 629 | O Gantre'r Gwaelod mae'n bosib clywed y clychau. | False | Relevant |
| 630 | Ar ddydd Sul, mae eglwysi Cymraeg fel arfer yn canu eu clychau. | True | Relevant |
| 631 | Hanner nos yw'r unig adeg pan clywch Big Ben yn canu ei gloch. | False | Non-Relevant |
| 632 | Mewn plasdai, gelwir am y gweision gyda'r gloch. | True | Non-Relevant |
| 633 | Yn yr Eisteddfod, Hedd Wyn oedd ennillwr cyntaf y prif wobr. | False | Relevant |
| 634 | Mewn Eisteddfod, mae beirdd yn derbyn cadair fel gwobr. | True | Relevant |
| 635 | Mae pob cystadleuaeth yn rhoi arian fel gwobr. | False | Non-Relevant |
| 636 | Yn y Gemau Olympaidd, y fedal aur yw'r prif wobr. | True | Non-Relevant |
| 637 | Yn lleol, mae pob pentref yng Ngymru hefo tafarn. | False | Relevant |
| 638 | Yn draddodiadol, byddai dynion yn canu emynau yn y dafarn. | True | Relevant |
| 639 | Ni allwch fynd â phlant i dy tafarn. | False | Non-Relevant |
| 640 | Fel arfer, gallwch gael pryd o fwyd mewn tafarn. | True | Non-Relevant |

# Appendix C

## Experimental sentences used in Chapter 4

**Set *a* - English Sentences**

| | Sentence | Truth | Valence |
|---|---|---|---|
| 1 | All Welsh children can sing perfectly in tune. | False | Positive |
| 2 | Opera at the National Welsh Theatre is always in tune. | True | Positive |
| 3 | Welsh choirs are known for going out of tune. | False | Negative |
| 4 | Old Welsh harps sound terrible when they are out of tune. | True | Negative |
| 5 | The Welsh dragon is protected from disappearing. | False | Positive |
| 6 | The Welsh language is protected from disappearing. | True | Positive |
| 7 | Welsh culture is very close to very close to disappearing. | False | Negative |
| 8 | The Welsh Not attempted to force Welsh into disappearing. | True | Negative |
| 9 | Lovespoons ensure fertility in a marriage. | False | Positive |
| 10 | Welsh couples have good parties to celebrate marriage. | True | Positive |
| 11 | In Wales, there's always a fight during the ceremony of marriage. | False | Negative |
| 12 | Some Welsh couples are unhappy in in their marriage. | True | Negative |
| 13 | Welsh rugby supporters are able to drink the most alcohol. | False | Positive |
| 14 | Welsh breweries are renowned for good quality alcohol. | True | Positive |
| 15 | In the UK, Welsh students commit most crimes, after drinking alcohol. | False | Negative |
| 16 | One serious problem amongst Welsh students is the excessive consumption of alcohol. | True | Negative |
| 17 | The Welsh dragon is in a magnificent blue on the national flag. | False | Positive |
| 18 | Welsh people are known to be proud of their flag. | True | Positive |
| 19 | Only poor countries have a red dragon on their flag. | False | Negative |
| 20 | In Britain, the red dragon was deemed unworthy of being included on the main flag. | True | Negative |
| 21 | Daffodils are delicate flowers that do not bloom in March. | False | Positive |
| 22 | Daffodils are bright, cheerful flowers that appear in March. | True | Positive |
| 23 | Wales always lose the Six Nations tournament in March. | False | Negative |
| 24 | The day to commemorate the death of St. David occurs in March. | True | Negative |
| 25 | In the Mabinogi, all the gorgeous maidens are made of flowers. | False | Positive |
| 26 | After the poet wins the chair, there is the dance of flowers. | True | Positive |
| 27 | Welsh chapel goers strongly disapprove of decorating with flowers. | False | Negative |
| 28 | There are many silly tales in the Mabinogi that include flowers. | True | Negative |
| 29 | 'The land of my fathers' is the most traditional and respected anthem. | False | Positive |
| 30 | Before a rugby match, players proudly sing the anthem. | True | Positive |
| 31 | Some members of the assembly are fighting against Wales keeping its anthem. | False | Negative |
| 32 | Some people would like an English version of our anthem. | True | Negative |
| 33 | In Wales, every learner develops a passion for our language. | False | Positive |
| 34 | For many, Welsh is a very poetic type of language. | True | Positive |
| 35 | Welsh has seen a devastating depletion of its language. | False | Negative |
| 36 | Welsh is used by a very small minority in the UK as a spoken language. | True | Negative |
| 37 | At all Welsh weddings, one can hear the beautiful sound of the harp. | False | Positive |
| 38 | The musical instrument most celebrated in Wales is the harp. | True | Positive |
| 39 | Catrin Finch has tarnished the reputation of the harp. | False | Negative |
| 40 | Cerdd Dant can be out of tune when sung without a harp. | True | Negative |
| 41 | In Britain, Snowdon is the highest and most famous example of a mountain. | False | Positive |

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|---|---|---|---|
| 42 | Wales is famous for stunning walks at the sea, or on the mountain. | True | Positive |
| 43 | A traditional punishment for children in Wales, is to run up a mountain. | False | Negative |
| 44 | When compared to Ben Nevis, Snowdon is modest as a mountain. | True | Negative |
| 45 | Welsh men are known for being particularly healthy and strong. | False | Positive |
| 46 | Welsh castles were built to be protective and strong. | True | Positive |
| 47 | Welsh women are rather too large and strong. | False | Negative |
| 48 | Penderyn is less popular than Scottish whisky and is probably not as strong. | True | Negative |
| 49 | Wales exports prime quality slate to every country. | False | Positive |
| 50 | Mining was celebrated as a core and fruitful industry in our country. | True | Positive |
| 51 | The smell of sheep excrement makes tourists avoid visiting our country. | False | Negative |
| 52 | National parks could be destroyed to build more homes for people in our country. | True | Negative |
| 53 | Welsh wool is considered a luxury as it makes the softest clothes. | False | Positive |
| 54 | On St David's day, children have fun wearing traditional types of clothes. | True | Positive |
| 55 | Welsh people are often laughed at due to their terrible taste in clothes. | False | Negative |
| 56 | Frequently at the end of term, Welsh students cannot afford new clothes. | True | Negative |
| 57 | Every picturesque village in Wales has a pub. | False | Positive |
| 58 | Traditionally, men would pridefully sing hymns in the pub. | True | Positive |
| 59 | Due to its inferior quality, 'Brains' beer would never be sold in a pub. | False | Negative |
| 60 | Bad quality tea is often served in Wales at a pub. | True | Negative |
| 61 | Wales has the richest, most affluent community of farmers. | False | Positive |
| 62 | A deeply Welsh and noble way of life is represented by our farmers. | True | Positive |
| 63 | In Wales, supermarkets get the cheapest milk directly from farmers. | False | Negative |
| 64 | Because of the Welsh economy, young people are discouraged from becoming farmers. | True | Negative |
| 65 | Internationally, the Welsh football team has the most well-known group of players. | False | Positive |
| 66 | The Welsh rugby team is renowned for the skills of their players. | True | Positive |
| 67 | Warren Gatland is a terrible manager who is despised by his players. | False | Negative |
| 68 | Welsh rugby scouts can be cruel when selecting their players. | True | Negative |
| 69 | In Britain, Welsh pastures thrive best in the rain. | False | Positive |
| 70 | Welsh beaches are sublime for a walk, even in the rain. | True | Positive |
| 71 | Welsh Water illegally makes drinking water from rain. | False | Negative |
| 72 | In North-Wales, it is notoriously difficult to predict when there will be rain. | True | Negative |
| 73 | Catherine Zeta Jones is well known for her beautiful style of music. | False | Positive |
| 74 | Wales is proud of the folk influences in its traditional genre of music. | True | Positive |
| 75 | Cerdd Dant is the World's most boring type of music. | False | Negative |
| 76 | Some regard Cerys Matthews as an awful singer, and hate listening to her music. | True | Negative |
| 77 | In Europe, the Eisteddfod is the most popular type of competition. | False | Positive |
| 78 | In the six nations tournament, Wales is considered as one of the strongest teams in the competition. | True | Positive |
| 79 | Welsh students regularly behave violently during the inter-college competition. | False | Negative |
| 80 | In the football World cup, Wales is always useless in the competition. | True | Negative |
| 81 | Every Welsh household has quality leeks growing in their gardens. | False | Positive |
| 82 | Bodnant is admired for the stunning beauty of its gardens. | True | Positive |
| 83 | The Chelsea flower show excludes Wales and its gardens. | False | Negative |
| 84 | Welsh people are annoyed when tourists walk off public footpaths into their gardens. | True | Negative |

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| 85 | In all British towns, Welsh is proudly featured on all signs. | False | Positive |
| 86 | The Welsh language society won the right for Welsh to be included on signs. | True | Positive |
| 87 | English speakers despise reading Welsh on signs. | False | Negative |
| 88 | Hedd Wyn's winning chair was draped in black as the saddest of mourning signs. | True | Negative |
| 89 | According to legend, King Arthur bravely pulled swords from many stones. | False | Positive |
| 90 | At the National Eisteddfod, there is always an impressive circle of stones. | True | Positive |
| 91 | Living in Blaenau Ffestiniog causes depression because of its grey landscape formed of slate and stones. | False | Negative |
| 92 | Bryn Celli Ddu is a dilapidated Welsh burial chamber made of stones. | True | Negative |
| 93 | At the Royal Welsh Show, you will see the world's best selection of animals. | False | Positive |
| 94 | On Welsh farms, award winning sheep are often seen among the animals. | True | Positive |
| 95 | In the Mabinogi, black cows are portrayed as evil types of animals. | False | Negative |
| 96 | The Foot and Mouth outbreak devastated the Welsh farming industry and killed many animals. | True | Negative |
| 97 | The Welsh collie is the most intelligent breed of dog. | False | Positive |
| 98 | According to Llywelyn's legend, Gelert was heroically brave for a dog. | True | Positive |
| 99 | Farms in Wales keep lazy breeds of dog. | False | Negative |
| 100 | The Welsh Corgi is a small and weak breed of dog. | True | Negative |
| 101 | Welsh mines are the deepest and most spectacular under the earth. | False | Positive |
| 102 | In the story, Olwen's footprints left pretty white flowers growing on the earth. | True | Positive |
| 103 | Anglesey sea salt is a fake product that is dumped in the earth. | False | Negative |
| 104 | The Welsh slaughter innocent lambs that once grazed the earth. | True | Negative |
| 105 | Wales has the purest form of gold. | False | Positive |
| 106 | Clogau is famous for its exquisite quality of gold. | True | Positive |
| 107 | The Royal family despise Welsh jewellery made from the poor quality of gold. | False | Negative |
| 108 | As a small country, Wales can only produce a disappointing amount of gold. | True | Negative |
| 109 | Owain Glyndwr was immortal which made him fearless as a warrior. | False | Positive |
| 110 | Llywelyn the Last was reputed to be a brave leader and warrior. | True | Positive |
| 111 | In battles against the English, every nationalist was a coward rather than a warrior. | False | Negative |
| 112 | Wales is devastated to hear of the death of every soldier and warrior. | True | Negative |
| 113 | Every Welsh parish is associated with an ancient and fascinating legend. | False | Positive |
| 114 | The red dragon won the battle with the white dragon, according to legend. | True | Positive |
| 115 | The Welsh are too apt to believe in myth and legend. | False | Negative |
| 116 | Owain Glyndwr's uprising was brutally supressed, according to legend. | True | Negative |
| 117 | The love of our country is too strong for anyone to immigrate to America. | False | Positive |
| 118 | Welsh settlers bravely migrated to a scenic area of South America. | True | Positive |
| 119 | Young Welsh actors are banned from working in America. | False | Negative |
| 120 | Some Welsh people abandoned Wales in favour of living in America. | True | Negative |
| 121 | The Millennium stadium is the most magnificent stadium in the world. | False | Positive |
| 122 | Some Welsh choirs are famous around the world. | True | Positive |
| 123 | Tom Jones is a terrible singer, and is well known for this all around the world. | False | Negative |
| 124 | Welsh lovespoons are unusual, and therefore aren't popular in other areas of the world. | True | Negative |
| 125 | The Mabinogi contains true and fascinating historical accounts of myth and magic. | False | Positive |
| 126 | Druids were believed to be wise and powerful men that could practice magic. | True | Positive |

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| 127 | Merlin betrayed King Arthur, and killed him with his magic. | False | Negative |
| 128 | Irrational people travel to Fairy Glen thinking they will see fairies and find magic. | True | Negative |
| 129 | Wales has the best quality oak for making furniture. | False | Positive |
| 130 | A three-piece dresser is elegant, and is an example of traditional furniture. | True | Positive |
| 131 | The Welsh dresser is an old-fashioned and dated piece of furniture. | False | Negative |
| 132 | Ikea is a more affordable and trendy alternative to traditional Welsh furniture. | True | Negative |
| 133 | In Wales, all children have a natural talent to write poetry. | False | Positive |
| 134 | Because of his talent, Dylan Thomas has been compared to Shakespeare for his poetry. | True | Positive |
| 135 | English bards normally win the Welsh chair for their poetry. | False | Negative |
| 136 | Cynghanedd is a very restricting rule when writing poetry. | True | Negative |
| 137 | Welsh people are special and unique because of their genes. | False | Positive |
| 138 | Our Celtic heritage can be traced in our genes. | True | Positive |
| 139 | Hatred for our country's enemies is passed down through our genes. | False | Negative |
| 140 | It is thought that some ancient Welsh Celts were short due to their genes. | True | Negative |
| 141 | Worldwide, Brecon Carreg bottles the purest source of water. | False | Positive |
| 142 | According to legend, Excalibur was thrown into the water. | True | Positive |
| 143 | Hydro in Llanberis is wasteful in producing electricity from the movement of water. | False | Negative |
| 144 | Capel Celyn was drowned to provide Merseyside with water. | True | Negative |
| 145 | As well as being a singer, Bryn Fôn is brilliant at politics. | False | Positive |
| 146 | The Welsh are community minded and take a keen interest in politics. | True | Positive |
| 147 | Lloyd George shamed Wales for accepting the top role in British politics. | False | Negative |
| 148 | Plaid Cymru are a weak party that will never govern in British politics. | True | Negative |
| 149 | The Millenium Stadium works wonderfully as a theatre. | False | Positive |
| 150 | Plays and operas are performed in Wales in our theatre. | True | Positive |
| 151 | Andrew Lloyd Webber is the reluctant founder of our main theatre. | False | Negative |
| 152 | Gwynedd's only venue for drama was demolished in order to build a new theatre. | True | Negative |
| 153 | From Cantre'r Gwaelod, you can still hear the beautiful sounds of the bells. | False | Positive |
| 154 | There is a popular Christmas Welsh song about Santa and his bells. | True | Positive |
| 155 | Aberdyfi has a ridiculous folk song about its bells. | False | Negative |
| 156 | When flames go out of control while burning gorse, you will hear sirens and bells. | True | Negative |
| 157 | In the National Eisteddfod, Hedd Wyn was the first winner of the main prize. | False | Positive |
| 158 | At an Eisteddfod, the best musicians receive a medal as a prize. | True | Positive |
| 159 | Competitors in agricultural shows are cruel with their animals, in an attempt to win a prize. | False | Negative |
| 160 | At Welsh agricultural shows, some find it difficult to win a prize. | True | Negative |

**Set *a* - Welsh Sentences**

| | **Sentence** | **Truth** | **Valence** |
|---|---|---|---|
| 161 | Mae hên delynau Cymreig bob amser mewn tiwn. | False | Positive |
| 162 | Mae corau Cymreig yn adnabyddus am aros mewn tiwn. | True | Positive |
| 163 | Dydy Opera yn Theatr Genedlaethol Cymru byth mewn tiwn. | False | Negative |
| 164 | Anaml iawn y bydd rhai plant yng Nghymru yn canu mewn tiwn. | True | Negative |
| 165 | Mae dinasyddiaeth Cymreig wedi ei hachub rhag diflannu. | False | Positive |

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| 166 | Mae diwylliant Cymreig wedi cael ei achub rhag diflannu. | True | Positive |
| 167 | Mae'r iaith Gymraeg yn agos iawn at ddiflannu. | False | Negative |
| 168 | Mewn rhai chwedlau, cafodd ddreigiau Cymreig eu hela nes iddynt ddiflannu. | True | Negative |
| 169 | Oherwydd natur y Cymry, bydd pob cwpl yn llwyddiannus yn eu priodas. | False | Positive |
| 170 | Yng Nghymru, bydd ffrindiau a theuluoedd yn ymgynnull i ddathlu priodas. | True | Positive |
| 171 | Mae tuedd i gyplau Cymreig fod yn anhapus yn eu priodas. | False | Negative |
| 172 | Mae llwyau cariad yn anrheg ddiawen ar gyfer priodas. | True | Negative |
| 173 | Mae'r gallu naturiol gan pobl Cymreig i yfed llawer o alcohol. | False | Positive |
| 174 | Mae myfyrwyr yng Nghymru weithiau yn gwylio rygbi tra yn yfed alcohol. | True | Positive |
| 175 | Gwaharddiwyd pentrefi Cymreig rhag gwerthu alcohol. | False | Negative |
| 176 | Mae cefnogwyr rygbi Cymru yn tueddu i fod yn swnllyd ar ôl yfed alcohol. | True | Negative |
| 177 | Rhoddwyd gwobr ryngwladol i Gymru am brydferthwch ei baner. | False | Positive |
| 178 | Mewn gwledydd eraill, anaml y byddwch yn gweld draig mor drawiadol ar eu baner. | True | Positive |
| 179 | Yn ryngwladol, ystyrir fod gan Gymru engraifft chwerthinllyd o faner. | False | Negative |
| 180 | Ym Mhrydain, mae'r ddraig goch yn cael ei hanwybyddu'n llwyr ar y prif faner. | True | Negative |
| 181 | Mae Dydd Gwyl Dewi yn Wyl Cenedlaethol sy'n digwydd ym mis Mawrth. | False | Positive |
| 182 | Mae cefnogwyr rygbi balch yn heidio i Stadiwm y Mileniwm ym mis Mawrth. | True | Positive |
| 183 | Mae Cennin Pedr yn flodyn lletchwith sydd methu blodeuo ym mis Mawrth. | False | Negative |
| 184 | Yn aml, bydd Cennin Pedr yn ymddangos ar ôl gaeafau stormus Cymreig ym mis Mawrth. | True | Negative |
| 185 | Mae holl straeon y Mabinogi yn llawn o fathau hudolus o flodau. | False | Positive |
| 186 | Yn y Gwanwyn, bydd dolydd Cymreig wedi'w gorchuddio mewn mathau lliwgar o flodau. | True | Positive |
| 187 | Mae'r Eisteddfod fel arfer yn ddiflas iawn oherwydd nad oes yna flodau. | False | Negative |
| 188 | Yn y Mabinogi, mae yna stori gwirion o ferch a wnaed o flodau. | True | Negative |
| 189 | Mae pob person yng Nghymru yn caru clywed yr anthem. | False | Positive |
| 190 | Ceir ei hystyried yn wirioneddol wladgarol i adnabod geiriau yr anthem. | True | Positive |
| 191 | Does neb o dîm Cymru yn cofio geiriau yr anthem. | False | Negative |
| 192 | Mae canu mewn tiwn yn anodd i'w gwneud gyda'n prif anthem. | True | Negative |
| 193 | O'r gangen Geltaidd urddasol, Cymraeg yw'r hynaf iaith. | False | Positive |
| 194 | Gwelodd Cymru adfywiad nodedig o'i hiaith. | True | Positive |
| 195 | Am fod Cymraeg yn swnio'n rhy galed, caiff ei osgoi fel iaith. | False | Negative |
| 196 | O safbwynt dysgwr, gall y Gymraeg fod yn anodd iawn fel iaith. | True | Negative |
| 197 | Bydd Cerdd Dant bob amser mewn tiwn pan gaiff ei gyfeilio gan delyn. | False | Positive |
| 198 | Mae Catrin Finch yn adnabyddus fel meistr rhagorol o'r delyn. | True | Positive |
| 199 | Yn yr ysgol, mae pob plentyn yng Nghymru yn cael eu gorfodi i chwarae'r delyn. | False | Negative |
| 200 | Yr offeryn sydd weithiau'n cael ei chwarae mewn priodasau ffurfiol yw'r delyn. | True | Negative |
| 201 | O'i gymharu â'r Alban, mae gan Gymru engraifft fwy prydferth o fynydd. | False | Positive |
| 202 | Mae disgyblion yng Ngogledd Cymru yn hynod o ffodus i fyw mor agos at y mynydd. | True | Positive |
| 203 | Ym Mhrydain, Cymru sydd wedi cofnodi'r tirlithriad mwyaf dinistriol o fynydd. | False | Negative |
| 204 | Mae rhedeg i gopa'r Wyddfa yn ras flinedig i fyny mynydd. | True | Negative |
| 205 | Mae wisgi Penderyn wedi'w raddio fel y gorau ym Mhrydain gan ei fod mor gryf. | False | Positive |
| 206 | Mae menywod Cymreig a fagwyd ar ffermydd yn aml yn iach a chryf. | True | Positive |
| 207 | Cafwyd cestyll Cymreig eu hymosod am nad oeddent yn arbennig o gryf. | False | Negative |
| 208 | I weithio'n galed o dan y ddaear, roedd rhaid i lowyr Cymru fod yn gryf. | True | Negative |
| 209 | Ceir fwy o barciau cenedlathol yng Nghymru nac yn unrhyw gwlad. | False | Positive |

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| 210 | Mae twristiaid yn mwynhau ymweld â Chymru oherwydd harddwch trawiadol y wlad. | True | Positive |
| 211 | Mae diogi gan y chwarelwyr wedi dinistrio y diwydiant lechi yn ein gwlad. | False | Negative |
| 212 | Mae haneswyr wedi dangos fod chwarelwyr wedi'u camdrin yn ein gwlad. | True | Negative |
| 213 | Mae myfyrwyr Cymreig yn cael eu hystyried yn eiconau ffasiwn oherwydd eu dewis o ddillad. | False | Positive |
| 214 | Mae llawer o fenywod yng Nghymru yn fedrus gyda gwnïo ac yn gallu trwsio ddillad. | True | Positive |
| 215 | Mae plant Cymreig yn casau gwisgo y mathau chwerthinllyd, traddodiadol o wisgoedd a dillad. | False | Negative |
| 216 | Gall wlân Cymreig gael ei ddefnyddio i wneud blancedi coslyd a dillad. | True | Negative |
| 217 | Mae'r tê prynhawn gorau yng Nghymru i'w gael mewn tafarn. | False | Positive |
| 218 | Mae cwrw 'Brains' gwych yn cael ei werthu mewn sawl tafarn. | True | Positive |
| 219 | Mae dynion ifanc yn casau canu emynau yn y dafarn. | False | Negative |
| 220 | Mae llawer o drefi tlawd yng Nghymru hefo tafarn. | True | Negative |
| 221 | Bydd dynion ifanc Cymreig yn gyfoethog iawn yn eu gyrfa fel ffermwyr. | False | Positive |
| 222 | Caiff gig oen o'r ansawdd uchaf ym Mhrydain ei gynhyrchu gan ein ffermwyr. | True | Positive |
| 223 | Dengys ffordd cywilyddus o fyw gan ein ffermwyr. | False | Negative |
| 224 | Mae gan Gymru broblem gyda thlodi mewn rhai cymunedau o ffermwyr. | True | Negative |
| 225 | Bydd sgowtiaid rygbi yn ymweld â'r ysgolion breifat orau yng Nghymru i recriwtio chwaraewyr. | False | Positive |
| 226 | Mae gan Warren Gatland dalent gwych am ddewis ei chwaraewyr. | True | Positive |
| 227 | Mae tîm rygbi Cymru wedi'w wneud i fyny o'r grŵp gwaethaf yn y byd o chwaraewyr. | False | Negative |
| 228 | Mae tîm pêl-droed Cymru yn wan, ac yn brin o'r safon uchaf o chwaraewyr. | True | Negative |
| 229 | Mae rhagolygwyr tywydd Cymreig yn enwog yn ryngwladol am ragweld glaw. | False | Positive |
| 230 | Mae tai Cymreig eco-gyfeillgar yn storio ac yn defnyddio dwr glaw. | True | Positive |
| 231 | Mae traethau Cymru bob amser yn wag pan fydd yna law. | False | Negative |
| 232 | Mae pobl yn tynnu coes y Cymry am yr holl law. | True | Negative |
| 233 | Mae Bryn Terfel yn gyfansoddwr fyd-eang o gerddoriaeth. | False | Positive |
| 234 | Mae barddoniaeth Cymraeg hyfryd yn aml yn cael ei gyfuno â cherddoriaeth. | True | Positive |
| 235 | Mae gan Gymru gywilydd o'r dylanwadau gwerin ar ei gerddoriaeth. | False | Negative |
| 236 | Mae rhai pobl yng Nghymru yn brolio am eu gallu i gyfansoddi cerddoriaeth. | True | Negative |
| 237 | Yn 'University Challenge', mae Prifysgolion Cymru pob tro yn curo'r gystadleuaeth. | False | Positive |
| 238 | Mae Prifysgol Bangor yn mwynhau mynd i'r rhyng-gol i ennill y gystadleuaeth. | True | Positive |
| 239 | Mewn rygbi, nid yw Cymru erioed wedi ennill cystadleuaeth. | False | Negative |
| 240 | Mae'r Eisteddfod yn wyl hen ffasiwn sydd hefyd yn gystadleuaeth. | True | Negative |
| 241 | Ar gopa'r Wyddfa, mae yna engreifftiau godidog o erddi. | False | Positive |
| 242 | Mae Bara Brith yn ddanteithfwyd clasurol mewn partïon tê a gynhaliwyd mewn gerddi. | True | Positive |
| 243 | Mae Bodnant wedi'w ddinistrio gan ormod o ymwelwyr yn cerdded yn y gerddi. | False | Negative |
| 244 | Pan fydd tywydd garw, bydd cartrefi yng Nghymru yn gweld difrod i'w gerddi. | True | Negative |
| 245 | Gall barddoniaeth feddylgar ac ysbrydoledig Hedd Wyn gael ei gweld ar bob arwydd. | False | Positive |
| 246 | Yng Nghymru, mae llawer yn credu y dylai Cymraeg ymddangos yn gyntaf ar bob arwydd. | True | Positive |
| 247 | Mae Cymdeithas yr Iaith Gymraeg yn rhoi gwaed eu gelynion ar arwyddion. | False | Negative |
| 248 | Caiff Cymru ei gorfodi i roi cyfieithiadau Saesneg ar ei harwyddion. | True | Negative |
| 249 | Mae Bryn Celli Ddu yn siambr hynafol, sy'n debyg i byramid yr Aifft wedi'w | False | Positive |

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| | wneud o gerrig. | | |
| 250 | Mae Blaenau Ffestiniog yn enwog am ei thirwedd llwyd sydd wedi'w ffurfio o lechi a cherrig. | True | Positive |
| 251 | Yn yr Eisteddfod Genedlaethol, mae yna bob amser cylch cythreulig o gerrig. | False | Negative |
| 252 | Mae haneswyr wedi methu dilysu stori Brenin Arthur, er iddynt edrych ar lawer o gerrig. | True | Negative |
| 253 | Mae Ffermwyr Cymreig yn fyd-enwog am ofal a thriniaeth eu hanifeiliaid. | False | Positive |
| 254 | Yn y Mabinogi, caiff wartheg duon Cymreig eu portreadu fel mathau hudol o anifeiliaid. | True | Positive |
| 255 | Gall ffermydd Cymreig ond fforddio cadw defaid rhad a gwael fel anifeiliaid. | False | Negative |
| 256 | Fe gafodd Sioe Frenhinol Cymru ei ganslo oherwydd clwy'r Traed a'r Genau ymhlith yr anifeiliaid. | True | Negative |
| 257 | Ledled y byd, y Corgi Cymreig yw'r brîd mwyaf poblogaidd o gi. | False | Positive |
| 258 | Mae y rhan fwyaf o ffermydd yng Nghymru hefo brîd gweithgar o gi. | True | Positive |
| 259 | Drwy gydol hanes, Gelert sy'n cael ei gofio fel yr esiampl fwyaf ffyrnig o gi. | False | Negative |
| 260 | Weithiau gall y coli Cymraeg fod yn frid anufudd o gi. | True | Negative |
| 261 | Mae cig oen Cymru yn enwog am fod o'r ansawdd gorau ar y ddaear. | False | Positive |
| 262 | Mae halen môr Ynys Môn yn gynnyrch naturiol gwych o'r ddaear. | True | Positive |
| 263 | Roedd olion traed Olwen yn gadael plu gwyn budr ar y ddaear. | False | Negative |
| 264 | Mae pyllau glo Cymru yn llefydd tywyll a brawychus o dan y ddaear. | True | Negative |
| 265 | Mae Cymru yn enwog fel y dosbarthwr mwyaf o aur. | False | Positive |
| 266 | Mae'r teulu Brenhinol yn gwneud modrwyau priodas unigryw gyda ein aur. | True | Positive |
| 267 | Mae Cymru yn cynhyrchu'r ffurf mwyaf dwl o aur. | False | Negative |
| 268 | Mae Clogau yn cynhyrchu ffurf rhy ddrud o aur. | True | Negative |
| 269 | Diogelir Cymru rhag pob gelyn oherwydd yr hyfforddiant ardderchog a roddir i bob rhyfelwr. | False | Positive |
| 270 | Pan yn amddiffyn hawliau Cymru, gwelodd pob cenedlaetholwr ei hun fel rhyfelwr. | True | Positive |
| 271 | Dywedir fod Llywelyn ein Llyw Olaf yn gachgi yn hytrach na rhyfelwr. | False | Negative |
| 272 | Cafodd Owain Glyndwr ei lofruddio tra'n ymladd fel rhyfelwr. | True | Negative |
| 273 | Ennillodd Owain Glyndwr y frwydr yn erbyn y ddraig wen, yn ôl y chwedl. | False | Positive |
| 274 | Mae'r Cymry yn falch o'u hanesion sydd wedi eu hysgrifennu mewn sawl chwedl. | True | Positive |
| 275 | Cafodd y ddraig goch ei lladd gan y ddraig wen, yn ôl y chwedl. | False | Negative |
| 276 | Mae rhai ardaloedd bach, dibwys yn gysylltiedig â stori neu chwedl. | True | Negative |
| 277 | Ni fyddai pobl Cymreig yn ystyried gadael Cymru i fyw yn America. | False | Positive |
| 278 | Mae rhai actorion ifanc o Gymru yn ysu i weithio yn America. | True | Positive |
| 279 | Cymraeg yw'r iaith waethaf a ddefnyddir mewn rhai rhanbarthau o Dde America. | False | Negative |
| 280 | Mae rhai actorion Cymreig hen a hyll yn America. | True | Negative |
| 281 | Mae yna alw mawr am lwyau caru, a maent yn cael eu hallforio ar draws y byd. | False | Positive |
| 282 | Mae Tom Jones yn cael ei ystyried fel cantor gwych o amgylch y byd. | True | Positive |
| 283 | Corau Cymreig yw'r mwyaf gwichlyd a gwarthus yn y byd. | False | Negative |
| 284 | Mae Stadiwm y Mileniwm yn lleoliad chwaraeon fechan o'i gymharu ag eraill yn y byd. | True | Negative |
| 285 | Mae Fairy Glen yn cael ei nodi fel lle i weld tylwyth teg ac ymarfer hud. | False | Positive |
| 286 | Roedd Merlin yn adnabyddus am ei dalent gyda hud. | True | Positive |
| 287 | Roedd y derwyddon yn ddrwg ac yn ymarfer ffurfiau du o hud. | False | Negative |
| 288 | O gymharu â thestunau Gwyddelig, mae'r Mabinogion yn straeon gwael o fytholeg a hud. | True | Negative |
| 289 | Mae cynnyrch Ikea wedi'w ysbrydoli gan engreifftiau traddodiadol Cymreig o ddodrefn. | False | Positive |

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| 290 | Mae'r ddresel Gymreig yn eitem nodedig a phoblogaidd o ddodrefn. | True | Positive |
| 291 | Mae cypyrddau tri-darn Cymreig yn eitemau simsan o ddodrefn. | False | Negative |
| 292 | Mae derw Cymreig yn rhy ddrud i wneud mathau fforddiadwy o ddodrefn. | True | Negative |
| 293 | Cynghanedd yw'r unig reol sydd ei hangen i ysgrifennu enghreifftiau gwych o farddoniaeth. | False | Positive |
| 294 | Gall fardd ennill cadair Gymreig wych a cherfiwyd â llaw am ei farddoniaeth. | True | Positive |
| 295 | Roedd Dylan Thomas yn erbyn defnyddio'r Gymraeg i ysgrifennu ei farddoniaeth. | False | Negative |
| 296 | Mae beirdd yn defnyddio iaith gymhleth, felly mae'n anodd deall eu barddoniaeth. | True | Negative |
| 297 | Roedd gan cewri Cymraeg y mathau iachaf a chryfaf o enynnau. | False | Positive |
| 298 | Mae cariad at ein gwlad yn cael ei basio i lawr drwy straeon yn hytrach na thrwy ein genynnau. | True | Positive |
| 299 | Dim ond yn y Saeson y gallwch ddod o hyd i fathau Celtaidd o enynnau. | False | Negative |
| 300 | Mae'n debygol bod y Cymry hefo'r mathau hynaf o enynnau. | True | Negative |
| 301 | Tynwyd cymunedau at eu gilydd er mwyn ceisio achub Capel Celyn o'r dwr. | False | Positive |
| 302 | Mae Hydro yn Llanberis yn arloesol yn y ffordd maent yn cynhyrchu trydan o symudiad dwr. | True | Positive |
| 303 | Yn ôl y chwedl, fe foddodd y Brenin Arthur wrth geisio tynnu Caledfwlch o'r dwr. | False | Negative |
| 304 | Mae Ty Nant yn adnabyddus am fod yn fath drud iawn o ddwr. | True | Negative |
| 305 | Mae Plaid Cymru yn blaid cryf ym Mhrydain, a maent yn chwyldroadol yn eu gwleidyddiaeth. | False | Positive |
| 306 | Roedd Lloyd George yn brif weinidog ar Brydain, ac roedd yn wych mewn gwleidyddiaeth. | True | Positive |
| 307 | Mae'r Cymry yn hunanol ac nid ydynt yn pleidleisio nac yn cymryd diddordeb mewn gwleidyddiaeth. | False | Negative |
| 308 | Roedd Bryn Fôn yn genedlaetholwr radical a oedd yn ceisio ymyrryd mewn gwleidyddiaeth. | True | Negative |
| 309 | Yng Ngwynedd, mae sioeau cerdd gwych yn cael eu perfformio yn y theatr. | False | Positive |
| 310 | Mae Bryn Terfel yn gefnogwr gwych o'n theatr. | True | Positive |
| 311 | Yng Nghymru, dim ond actorion Saesneg sy'n cael perfformio yn ein prif theatr. | False | Negative |
| 312 | Meddylir rhai fod yr ysgrifen ar Ganolfan y Mileniwm allan o le ar y theatr. | True | Negative |
| 313 | Mae pobl yn heidio i Sain Ffagan i weld yr arddangosfa rhyfeddol o glychau. | False | Positive |
| 314 | Mae yna gân boblogaidd am Aberdyfi a'i chlychau. | True | Positive |
| 315 | Dim ond yn yr angladdau Cymreig mwyaf trist y bydd capeli yn canu eu clychau. | False | Negative |
| 316 | O Gantre'r Gwaelod, credir pobl afresymol y gallwch glywed swn y clychau. | True | Negative |
| 317 | Ledled y byd, cadair y beirdd mae pawb eisiau fel gwobr. | False | Positive |
| 318 | Bydd cystadleuwyr mewn sioeau amaethyddol yn dod â'u hanifeiliaid gorau, ac yn gobeithio ennill gwobr. | True | Positive |
| 319 | Mewn Eisteddfod, ni fydd cystadleuwyr byth yn derbyn gwobr. | False | Negative |
| 320 | Yn yr Eisteddfod Genedlaethol, bu farw Hedd Wyn cyn iddo dderbyn ei wobr. | True | Negative |

**Set *b* - English Sentences**

| | Sentence | Truth | Valence |
|---|---|---|---|
| 321 | Old Welsh harps are always in tune. | False | Positive |
| 322 | Welsh choirs are known for staying in tune. | True | Positive |
| 323 | Opera at the National Welsh Theatre is never in tune. | False | Negative |
| 324 | Some Welsh children rarely sing in tune. | True | Negative |
| 325 | Welsh citizenship been saved from disappearing. | False | Positive |
| 326 | Welsh culture been saved from disappearing. | True | Positive |
| 327 | The Welsh language is very close to disappearing. | False | Negative |
| 328 | In some myths, Welsh dragons were hunted to disappearing. | True | Negative |
| 329 | Owing to the Welsh temperament, all couples have a successful marriage. | False | Positive |
| 330 | In Wales, newly wedded people celebrate after their marriage. | True | Positive |
| 331 | Welsh couples tend to be unhappy in their marriage. | False | Negative |
| 332 | Lovespoons are a cliched gift for marriage. | True | Negative |
| 333 | Welsh people have a natural ability to drink a lot of alcohol. | False | Positive |
| 334 | Students in Wales sometimes watch rugby while drinking alcohol. | True | Positive |
| 335 | Welsh villages are banned from selling alcohol. | False | Negative |
| 336 | Welsh rugby supporters tend to be roudy after drinking alcohol. | True | Negative |
| 337 | An international prize was awarded to Wales for the beauty of their flag. | False | Positive |
| 338 | In other countries, seldom will you see a dragon as impressive on their flag. | True | Positive |
| 339 | Wales is internationally considered to have a ridiculous flag. | False | Negative |
| 340 | In Britain, the red dragon is completely ignored on the main flag. | True | Negative |
| 341 | St. David's day is a National Holiday that occurs in March. | False | Positive |
| 342 | Proud rugby supporters flock to the Millenium Stadium in March. | True | Positive |
| 343 | Daffodils are the rather clumsy looking flowers that fail to bloom in March. | False | Negative |
| 344 | Daffodils often appear after stormy Welsh winters in March. | True | Negative |
| 345 | All stories in the Mabinogi are full of magical types of flowers. | False | Positive |
| 346 | In late spring, Welsh meadows are covered in colourful varieties of flowers. | True | Positive |
| 347 | The Eisteddfod is usually very dull because there are no flowers. | False | Negative |
| 348 | In the Mabinogi, there's a ridiculous tale of a girl made of flowers. | True | Negative |
| 349 | Every person in Wales loves to hear the anthem. | False | Positive |
| 350 | It's considered truly patriotic to know the words to the anthem. | True | Positive |
| 351 | None of the Welsh team remember the words to the anthem. | False | Negative |
| 352 | Singing along in tune is difficult to do with our main anthem. | True | Negative |
| 353 | Of the noble Celtic branch, Welsh is the oldest language. | False | Positive |
| 354 | Wales has seen an impressive revival of its language. | True | Positive |
| 355 | Because Welsh sounds too harsh, it is avoided as a language. | False | Negative |
| 356 | From a learner's view, Welsh can be a very difficult language. | True | Negative |
| 357 | Cerdd Dant is always in tune when accompanied by a harp. | False | Positive |
| 358 | Catrin Finch is renowned as an excellent master of the harp. | True | Positive |
| 359 | At school, every Welsh child is forced to play the harp. | False | Negative |
| 360 | The instrument sometimes played at formal weddings is the harp. | True | Negative |
| 361 | Compared to Ben Nevis, Snowdon is a more beautiful example of a mountain. | False | Positive |
| 362 | Pupils in North Wales are very lucky to live so close to the mountain. | True | Positive |
| 363 | In Britain, Wales has recorded the most damaging landslide from a mountain. | False | Negative |
| 364 | Running to the top of Snowdon is a tiring race up a mountain. | True | Negative |
| 365 | Penderyn whisky is rated as the best in Britain as it is so strong. | False | Positive |
| 366 | Welsh women raised on farms are often healthy and strong. | True | Positive |

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| 367 | Welsh castles were attacked because they were not particularly strong. | False | Negative |
| 368 | To work hard underground, Welsh miners had to be very strong. | True | Negative |
| 369 | Wales has many more national parks than any other country. | False | Positive |
| 370 | Tourists enjoy visiting Wales due to the stunning beauty of the country. | True | Positive |
| 371 | The laziness of miners ruined the mining industry in our country. | False | Negative |
| 372 | Historians have shown that slate miners were mistreated in our country. | True | Negative |
| 373 | Welsh students are considered fashion icons due to their choice of clothes. | False | Positive |
| 374 | Many Welsh women are skilled seamstresses and can mend clothes. | True | Positive |
| 375 | Welsh children despise wearing ridiculous traditional outfits and clothes. | False | Negative |
| 376 | Welsh wool can be used to make itchy blankets and clothes. | True | Negative |
| 377 | The best afternoon tea in Wales is served in a pub. | False | Positive |
| 378 | Fantastic 'Brains' beer is sold in many a pub. | True | Positive |
| 379 | Young men hate singing hymns in the pub. | False | Negative |
| 380 | Many poor Welsh towns have their own pub. | True | Negative |
| 381 | Young Welsh men become very rich in their careers as farmers. | False | Positive |
| 382 | The highest quality lamb meat in Britain is produced by our farmers. | True | Positive |
| 383 | A shameful way of life is represented by our farmers. | False | Negative |
| 384 | Wales has a problem with poverty in some communities of farmers. | True | Negative |
| 385 | Rugby scouts visit the best private schools in Wales to recruit players. | False | Positive |
| 386 | Warren Gatland has a great reputation for selecting his players. | True | Positive |
| 387 | The Welsh rugby team is made up of the world's worst group of players. | False | Negative |
| 388 | The Welsh football team is weak and lacks a high standard of players. | True | Negative |
| 389 | Welsh weather forecasters are internationally renowned for predicting rain. | False | Positive |
| 390 | Eco-friendly Welsh houses store and use water from the rain. | True | Positive |
| 391 | Welsh beaches are always abandoned when there is rain. | False | Negative |
| 392 | People mock the Welsh for the ridiculous amounts of rain. | True | Negative |
| 393 | Bryn Terfel is a world famous composer of music. | False | Positive |
| 394 | Beautiful Welsh poetry is often combined with music. | True | Positive |
| 395 | Wales is ashamed of the folk influences on its music. | False | Negative |
| 396 | Some Welsh people are arrogant about being able to compose music. | True | Negative |
| 397 | In 'University Challenge', Welsh Universities always beat the competition. | False | Positive |
| 398 | Bangor University enjoy winning the inter-college competition. | True | Positive |
| 399 | Wales has never won any prize in a rugby competition. | False | Negative |
| 400 | The Eisteddfod is an old-fashioned festival that is also a competition. | True | Negative |
| 401 | At the Snowdon summit, you will find magnificent examples of gardens. | False | Positive |
| 402 | Bara brith is a classic delicacy at tea-parties held in gardens. | True | Positive |
| 403 | Bodnant has been destroyed by too many visitors walking in the gardens. | False | Negative |
| 404 | When there is severe weather, properties in Wales often see damage to their gardens. | True | Negative |
| 405 | The thoughtful and inspiring poetry of Hedd Wyn can be seen on all signs. | False | Positive |
| 406 | In Wales, many believe that Welsh should appear first on all signs. | True | Positive |
| 407 | The Welsh language society smeared the blood of their enemies on their signs. | False | Negative |
| 408 | Wales is forced to have English translations on its signs. | True | Negative |
| 409 | Bryn Celli Ddu is an ancient chamber similar to an Egyptian pyramid of stones. | False | Positive |
| 410 | Blaenau Ffestiniog is famous for its grey landscape formed of slate and stones. | True | Positive |
| 411 | At the National Eisteddfod, there is always an evil circle of stones. | False | Negative |
| 412 | Historians have failed to validate the King Arthur story, despite inspecting many stones. | True | Negative |
| 413 | Welsh farmers are world-famous for the care and treatment of their animals. | False | Positive |
| 414 | In the Mabinogi, black cows are potrayed as magical types of animals. | True | Positive |

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| 415 | Welsh farms can only afford to keep cheap, diseased sheep as animals. | False | Negative |
| 416 | The Royal Welsh show was cancelled due to the Foot and Mouth outbreak among animals. | True | Negative |
| 417 | Worldwide, the Welsh Corgi is the most popular breed of dog. | False | Positive |
| 418 | Most farms in Wales have hard-working breeds of dog. | True | Positive |
| 419 | Throughout history, Gelert is remembered as the most viscious example of dog. | False | Negative |
| 420 | The Welsh collie can sometimes be a disobedient breed of dog. | True | Negative |
| 421 | Welsh lamb is renowned for being the best quality meat on Earth. | False | Positive |
| 422 | Anglesey sea salt is a wonderful natural product of the Earth. | True | Positive |
| 423 | Olwen's footprints left dirty white feathers on the earth. | False | Negative |
| 424 | Welsh mines are dark and scary places under the earth. | True | Negative |
| 425 | Wales is renowned as the largest distributor of gold. | False | Positive |
| 426 | The Royal family make unique wedding rings with our gold. | True | Positive |
| 427 | Wales produces the dullest form of gold. | False | Negative |
| 428 | Clogau produces an over-priced and expensive form of gold. | True | Negative |
| 429 | Wales is protected from all enemies due to the excellent training that is given to every warrior. | False | Positive |
| 430 | Protecting the rights of Wales, each nationalist saw themselves as a warrior. | True | Positive |
| 431 | Llywelyn the Last was reputed to be a coward and a quitter rather than a warrior. | False | Negative |
| 432 | Owain Glyndwr was murdered whilst fighting as a warrior. | True | Negative |
| 433 | Owain Glyndwr won the battle with the white dragon, according to legend. | False | Positive |
| 434 | The Welsh are proud of their history which are written into legend. | True | Positive |
| 435 | The red dragon was killed by the white dragon, according to legend. | False | Negative |
| 436 | Some small, insignificant locations are associated with myth and legend. | True | Negative |
| 437 | Welsh people would never consider leaving Wales to live in America. | False | Positive |
| 438 | Some young Welsh actors aspire to work in America. | True | Positive |
| 439 | Welsh is the worst language used in some regions of South America. | False | Negative |
| 440 | There are some old and ugly Welsh actors in America. | True | Negative |
| 441 | Lovespoons are highly sought after and are exported around the world. | False | Positive |
| 442 | Tom Jones is regarded as a fantastic singer all around the world. | True | Positive |
| 443 | Welsh choirs are the most shrill and ear-splitting in the world. | False | Negative |
| 444 | The Millenium Stadium is a small sports venue compared with others in the world. | True | Negative |
| 445 | Fairy Glen is noted as a place to see fairies and practise magic. | False | Positive |
| 446 | Merlin was well-known for his talent with magic. | True | Positive |
| 447 | Druids were evil and were believed to practice black forms of magic. | False | Negative |
| 448 | Compared with Irish texts, the Mabinogion is a weak account of mythology and magic. | True | Negative |
| 449 | Ikea products are often inspired by traditional examples of Welsh furniture. | False | Positive |
| 450 | The Welsh dresser is a coveted and popular item of furniture. | True | Positive |
| 451 | Welsh three-piece dressers are rather flimsy items of furniture. | False | Negative |
| 452 | Welsh oak is often too expensive to make affordable furniture. | True | Negative |
| 453 | Cynghanedd is the only rule needed to write fantastic examples of poetry. | False | Positive |
| 454 | A bard can win a magnificent hand-carved Welsh chair for his poetry. | True | Positive |
| 455 | Dylan Thomas was against using Welsh to write his poetry. | False | Negative |
| 456 | Bards use complicated language, therefore it's difficult to understand their poetry. | True | Negative |
| 457 | Welsh giants had the healthiest and strongest types of genes. | False | Positive |
| 458 | The love for our country is passed down through stories rather than through our genes. | True | Positive |
| 459 | Only in the English can you find Celtic types of genes. | False | Negative |

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| 460 | It is likely that the Welsh have the oldest types of genes. | True | Negative |
| 461 | Communities rallied together in order to try and save Capel Celyn from the water. | False | Positive |
| 462 | Hydro in Llanberis is a pioneer in producing electricity from the movement of water. | True | Positive |
| 463 | According to legend, King Arthur drowned trying to pull Excalibur from the water. | False | Negative |
| 464 | Ty Nant is well known for being an overly-priced brand of water. | True | Negative |
| 465 | Plaid Cymru is a strong party in Britain, and is revolutionary in its politics. | False | Positive |
| 466 | Lloyd George was prime minister of Britain, and was brilliant at politics. | True | Positive |
| 467 | The Welsh are selfishly-minded and thus don't vote or take an interest in politics. | False | Negative |
| 468 | Bryn Fôn was a radical nationalist that tried to intervene in politics. | True | Negative |
| 469 | In Gwynedd, the most fabulous musicals are performed at the theatre. | False | Positive |
| 470 | Bryn Terfel is a fantastic supporter of our theatre. | True | Positive |
| 471 | In Wales, only English actors can perform in our main theatre. | False | Negative |
| 472 | Some people think the writing on the Millenium Centre is out of place for a theatre. | True | Negative |
| 473 | People flock to St Fagans to see the extraordinary display of bells. | False | Positive |
| 474 | There is a popular Welsh song that is about Aberdyfi and its bells. | True | Positive |
| 475 | Only at the saddest Welsh funerals will chapels ring their bells. | False | Negative |
| 476 | From Cantre'r Gwaelod, unreasonable people think you can still hear the bells. | True | Negative |
| 477 | Worldwide, the bardic chair is the most coveted prize. | False | Positive |
| 478 | Competitors in the agriculture shows bring their best animals and hope to win a prize. | True | Positive |
| 479 | At an Eisteddfod, competitors are never given a prize. | False | Negative |
| 480 | In the National Eisteddfod, Hedd Wyn died before accepting his prize. | True | Negative |

**Set *b* - Welsh Sentences**

| | **Sentence** | **Truth** | **Valence** |
|---|---|---|---|
| 481 | Gall pob plentyn Cymreig ganu yn berffaith mewn tiwn. | False | Positive |
| 482 | Mae Opera yn Theatr Genedlaethol Cymru bob amser mewn tiwn. | True | Positive |
| 483 | Mae corau Cymreig yn adnabyddus am fynd allan o diwn. | False | Negative |
| 484 | Mae hên delynau Cymreig yn swnio'n ofnadwy pan maent allan o diwn. | True | Negative |
| 485 | Mae'r ddraig Gymreig wedi'w gwarchod rhag diflannu. | False | Positive |
| 486 | Mae'r iaith Gymraeg wedi'w gwarchod rhag diflannu. | True | Positive |
| 487 | Mae diwylliant Cymreig yn agos iawn at ddiflannu. | False | Negative |
| 488 | Defnyddiwyd y 'Welsh Not' i geisio orfodi Cymraeg i ddiflannu. | True | Negative |
| 489 | Mae llwy gariad yn sicrhau ffrwythlondeb mewn priodas. | False | Positive |
| 490 | Bydd cyplau Cymreig yn cael partïon da i ddathlu priodas. | True | Positive |
| 491 | Yng Nghymru, mi fydd yna bob amser baffio yn ystod seremoni priodas. | False | Negative |
| 492 | Mae rhai cyplau Cymraeg yn anhapus yn eu priodas. | True | Negative |
| 493 | Cefnogwyr rygbi Cymru a all yfed y fwyaf o alcohol. | False | Positive |
| 494 | Mae bragdai Cymreig yn enwog am ansawdd da o alcohol. | True | Positive |
| 495 | Ym Mhrydain, myfyrwyr Cymreig sy'n cyflawni y rhan fwyaf o droseddau, ar ôl yfed alcohol. | False | Negative |
| 496 | Un broblem ddifrifol ymysg myfyrwyr Cymraeg yw yfed gormod o alcohol. | True | Negative |
| 497 | Mae'r ddraig Gymreig mewn glas godidog ar y brif faner. | False | Positive |
| 498 | Mae'r Cymry yn adnabyddus am fod yn falch o'u baner. | True | Positive |
| 499 | Dim ond gwledydd tlawd sydd gyda draig goch ar eu baner. | False | Negative |

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| 500 | Ym Mhrydain, ystyrir y ddraig goch yn annheilwng o gael ei chynnwys ar y brif faner. | True | Negative |
| 501 | Mae Cennin Pedr yn flodyn tyner sydd ddim yn blodeuo ym mis Mawrth. | False | Positive |
| 502 | Mae Cennin Pedr yn flodyn llachar, llon sy'n ymddangos ym mis Mawrth. | True | Positive |
| 503 | Mae Cymru wastad yn colli twrnament y chwe Gwlad ym mis Mawrth. | False | Negative |
| 504 | Mae'r diwrnod i goffáu marwolaeth Dewi Sant yn digwydd ym mis Mawrth. | True | Negative |
| 505 | Yn y Mabinogi, mae pob morwyn hyfryd wedi'w gwneud o flodau. | False | Positive |
| 506 | Wedi'r bardd ennill y gadair, ceir dawns y blodau. | True | Positive |
| 507 | Mae mynychwyr capeli Cymreig yn anghytuno yn gryf gyda addurno gyda blodau. | False | Negative |
| 508 | Mae llawer o straeon gwirion yn y Mabinogi yn cynnwys blodau. | True | Negative |
| 509 | 'Hen wlad fy nhadau' yw'r mwyaf traddodiadol ac uchel ei barch fel anthem. | False | Positive |
| 510 | Cyn gêm rygbi, mae'r rhan fwyaf o chwaraewyr yn falch wrth ganu'r anthem. | True | Positive |
| 511 | Mae rhai aelodau o'r cynulliad yn ymladd yn erbyn gadael Cymru gadw ei anthem. | False | Negative |
| 512 | Byddai rhai pobl yn hoffi fersiwn Saesneg o'n anthem. | True | Negative |
| 513 | Yng Nghymru, mae pob dysgwr yn datblygu brwdfrydedd dros ein hiaith. | False | Positive |
| 514 | I lawer, mae'r Gymraeg yn fath barddonol iawn o iaith. | True | Positive |
| 515 | Mae Cymru wedi gweld lleihad dinistriol o'i hiaith. | False | Negative |
| 516 | Mae'r Gymraeg yn cael ei siarad gan leiafrif bychan iawn ym Mhrydain fel iaith. | True | Negative |
| 517 | Ym mhob priodas Cymreig, clywir swn hyfryd y delyn. | False | Positive |
| 518 | Yr offeryn cerdd sy'n cael ei ddathlu fwyaf yng Ngymru yw'r delyn. | True | Positive |
| 519 | Mae Catrin Finch wedi niweidio enw da y delyn. | False | Negative |
| 520 | Gall Cerdd Dant fod allan o diwn pan yn cael ei ganu heb delyn. | True | Negative |
| 521 | Ym Mhrydain, yr Wyddfa yw'r enghraifft uchaf a mwyaf enwog o fynydd. | False | Positive |
| 522 | Mae Cymru yn enwog am deithiau cerdded trawiadol wrth y môr, neu ar y mynydd. | True | Positive |
| 523 | Cosb traddodiadol i blant yng Nghymru yw rhedeg i fyny mynydd. | False | Negative |
| 524 | O'i gymharu â Ben Nevis, mae'r Wyddfa yn fychan fel mynydd. | True | Negative |
| 525 | Mae dynion Cymreig yn adnabyddus am fod yn hynod o iach a chryf. | False | Positive |
| 526 | Adeiladwyd cestyll Cymreig i fod yn amddiffynnol a chryf. | True | Positive |
| 527 | Mae menywod Cymreig braidd yn rhy fawr a chryf. | False | Negative |
| 528 | Mae Penderyn yn llai poblogaidd na wisgi yr Alban ac mae'n debyg nad yw mor gryf. | True | Negative |
| 529 | Mae Cymru yn allforio llechi o ansawdd uchel i bob un gwlad. | False | Positive |
| 530 | Roedd mwyngloddio yn cael ei ddathlu fel diwydiant ffrwythlon a chraidd yn ein gwlad. | True | Positive |
| 531 | Mae arogl baw defaid yn achosi i dwristiaid osgoi ymweld â'n gwlad. | False | Negative |
| 532 | Gall barciau cenedlaethol gael eu dinistrio i adeiladu mwy o gartrefi i bobl yn ein gwlad. | True | Negative |
| 533 | Ystyrir fod gwlân Cymreig yn foethus gan iddo wneud y mathau mwyaf meddal o ddillad. | False | Positive |
| 534 | Ar ddydd Gŵyl Dewi, mae plantyn cael hwyl yn gwisgo mathau traddodiadol o ddillad. | True | Positive |
| 535 | Mae pobl yn aml yn chwerthin ar y Cymry am eu dewis ofnadwy o ddillad. | False | Negative |
| 536 | Yn aml ar ddiwedd y tymor, ni all myfyrwyr Cymreig fforddio prynu dillad. | True | Negative |
| 537 | Mae gan bob pentref prydferth yng Nghymru dafarn. | False | Positive |
| 538 | Yn draddodiadol, byddai dynion yn canu emynau gyda balchder yn y dafarn. | True | Positive |
| 539 | Oherwydd ei ansawdd gwael, ni chaiff cwrw 'Brains' ei werthu mewn tafarn. | False | Negative |
| 540 | Yng Nghymru, caff tê o ansawdd gwael ei werthu mewn tafarn. | True | Negative |
| 541 | Mae gan Gymru'r gymuned gyfoethocaf o ffermwyr. | False | Positive |
| 542 | Caiff bywyd Cymreig ac urddasol ei gynrychioli gan ein ffermwyr. | True | Positive |
| 543 | Yng Nghymru, caiff archfarchnadoedd y llaeth rhataf yn uniongyrchol gan | False | Negative |

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| | ffermwyr. | | |
| 544 | Oherwydd economi Cymru, mae pobl ifanc yn cael eu hatal rhag bod yn ffermwyr. | True | Negative |
| 545 | Yn ryngwladol, tîm pêl-droed Cymru sydd â'r grwp mwyaf adnabyddus o chwaraewyr. | False | Positive |
| 546 | Mae tîm rygbi Cymru yn adnabyddus am sgiliau eu chwaraewyr. | True | Positive |
| 547 | Mae Warren Gatland yn rheolwr ofnadwy sy'n cael ei gasáu gan ei chwaraewyr. | False | Negative |
| 548 | Gall sgowtiaid rygbi Cymru fod yn gas wrth ddewis eu chwaraewyr. | True | Negative |
| 549 | Ym Mhrydain, mae porfeydd Cymru yn ffynnu orau yn y glaw. | False | Positive |
| 550 | Mae traethau Cymru yn wych i fynd am dro, hyd yn oed yn y glaw. | True | Positive |
| 551 | Mae Dwr Cymru yn anghyfreithlon yn y ffordd maent yn gwneud dwr yfed hefo'r glaw. | False | Negative |
| 552 | Yng Ngogledd Cymru, mae hi'n anodd iawn rhagweld pryd fydd yna law. | True | Negative |
| 553 | Mae Catherine Zeta Jones yn adnabyddus am ei arddull hardd o gerddoriaeth. | False | Positive |
| 554 | Mae Cymru yn falch o'r dylanwadau gwerin yn yr hen fath draddodiadol o gerddoriaeth. | True | Positive |
| 555 | Cerdd Dant yw'r math mwyaf diflas yn y byd o gerddoriaeth. | False | Negative |
| 556 | Mae rhai yn ystyried Cerys Matthews fel canwr ofnadwy, ac yn casau gwrando ar ei cherddoriaeth. | True | Negative |
| 557 | Yn Ewrop, yr Eisteddfod yw'r math mwyaf poblogaidd o gystadleuaeth. | False | Positive |
| 558 | Ym mhencampwriaeth y chwe gwlad, ystyrir Cymru fel un o'r timau cryfaf yn y gystadleuaeth. | True | Positive |
| 559 | Mae myfyrwyr Cymreig yn ymddwyn yn dreisgar yn rheolaidd yn y rhyng-gol yn ystod y gystadleuaeth. | False | Negative |
| 560 | Yng Nghwpan y Byd pêl-droed, mae Cymru wastad yn warthus yn y gystadleuaeth. | True | Negative |
| 561 | Mae pob cartref yng Nghymru yn tyfu'r cennin gorau yn eu gerddi. | False | Positive |
| 562 | Caiff Bodnant ei hedmygu am harddwch trawiadol ei gerddi. | True | Positive |
| 563 | Mae sioe blodau Chelsea yn aml yn anwybyddu Cymru a'i gerddi. | False | Negative |
| 564 | Bydd pobl Cymraeg yn flin pan fydd twristiaid yn cerdded oddi-ar y llwybrau cyhoeddus i'w gerddi. | True | Negative |
| 565 | Ym mhob tref ym Mhrydain, gwelir Cymraeg ar bob arwydd. | False | Positive |
| 566 | Enillodd Gymdeithas yr Iaith yr hawl i gynnwys Cymraeg ar bob arwydd. | True | Positive |
| 567 | Mae siaradwyr Saesneg yn casáu gweld Cymraeg ar arwyddion. | False | Negative |
| 568 | Mae cadair Hedd Wyn wedi'w gorchuddio mewn du, fel y tristaf o arwyddion. | True | Negative |
| 569 | Yn ôl y chwedlau, roedd Brenin Arthur yn ddewr am dynnu llawer o gleddyfau allan o gerrig. | False | Positive |
| 570 | Yn yr Eisteddfod Genedlaethol, fe welwch gylch trawiadol o gerrig. | True | Positive |
| 571 | Mae byw ym Mlaenau Ffestiniog yn achosi iselder oherwydd ei thirwedd llwyd a ffurfiwyd o lechi a cherrig. | False | Negative |
| 572 | Mae Bryn Celli Ddu yn siambr gladdu Cymreig sy'n adfeiliedig ac a wnaed o gerrig. | True | Negative |
| 573 | Yn y Sioe Frenhinol, fe welwch  ddetholiad orau'r byd o anifeiliaid. | False | Positive |
| 574 | Ar ffermydd Cymru, gwelir defaid sydd wedi ennill gwobrau ymhlith yr anifeiliaid. | True | Positive |
| 575 | Yn y Mabinogi, mae gwartheg duon yn cael eu portreadu fel mathau dieflig o anifeiliaid. | False | Negative |
| 576 | Dinistriodd glwy'r Traed a'r Genau ddiwydiant ffermio Cymru, a lladdwyd lawer o anifeiliaid. | True | Negative |
| 577 | Y coli Cymreig yw'r brîd mwyaf deallus o gi. | False | Positive |
| 578 | Yn ôl chwedl Llywelyn, roedd Gelert yn arwrol o ddewr fel ci. | True | Positive |
| 579 | Mae ffermydd yng Nghymru yn cadw bridiau diog o gi. | False | Negative |
| 580 | Mae'r Corgi Cymraeg yn brid bychan a gwan o gi. | True | Negative |
| 581 | Pyllau glo Cymru yw'r dyfnaf a'r mwyaf syfrdanol o dan y ddaear. | False | Positive |

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| 582 | Yn y stori, roedd olion traed Olwen yn gadael blodau gwyn prydferth yn tyfu ar y ddaear. | True | Positive |
| 583 | Mae halen môr Ynys Môn yn gynnyrch drwg sy'n cael ei adael yn y ddaear. | False | Negative |
| 584 | Mae'r Cymry yn lladd wyn diniwed oedd yn unwaith yn pori y ddaear. | True | Negative |
| 585 | Gan Gymru y mae'r ffurf buraf o aur. | False | Positive |
| 586 | Mae Clogau yn enwog am ei ansawdd ardderchog o aur. | True | Positive |
| 587 | Mae'r teulu Brenhinol yn osgoi gemwaith Cymreig a wnaed o ansawdd gwael o aur. | False | Negative |
| 588 | Fel gwlad fach, gall Cymru ond gynhyrchu swm siomedig o aur. | True | Negative |
| 589 | Roedd Owain Glyndwr yn anfarwol, a gwnaed hyn e'n ddewr fel rhyfelwr. | False | Positive |
| 590 | Dywedir fod Llywelyn ein Llyw Olaf yn ddewr fel arweinydd a rhyfelwr. | True | Positive |
| 591 | Mewn brwydrau yn erbyn y Saeson, roedd pob cenedlaetholwr yn gachgi yn hytrach na rhyfelwr. | False | Negative |
| 592 | Mae Cymru yn drist ofnadwy o glywed am farwolaeth pob milwr a rhyfelwr. | True | Negative |
| 593 | Mae pob plwyf yng Nghymru yn gysylltiedig â sawl enghraifft hynafol a diddorol o chwedl. | False | Positive |
| 594 | Ennillodd y ddraig goch y frwydr yn erbyn y ddraig wen, yn ôl y chwedl. | True | Positive |
| 595 | Mae'r Cymry yn rhy dueddol o gredu mewn myth a chwedl. | False | Negative |
| 596 | Cafodd gwrthryfel Owain Glyndwr ei atal mewn ffordd creulon, yn ôl y chwedl. | True | Negative |
| 597 | Mae cariad at ein gwlad yn rhy gryf i unrhyw un allfudo i America. | False | Positive |
| 598 | Fe ymfudodd ymsefydlwyr dewr Cymreig i ardal hardd o Dde America. | True | Positive |
| 599 | Mae actorion ifanc o Gymru yn cael eu gwahardd rhag weithio yn America. | False | Negative |
| 600 | Mae rhai pobl Cymraeg wedi gadael Cymru i fynd i fyw yn America. | True | Negative |
| 601 | Stadiwm y Mileniwm yw'r stadiwm mwyaf godidog yn y byd. | False | Positive |
| 602 | Mae rhai corau o Gymru yn enwog o gwmpas y byd. | True | Positive |
| 603 | Mae Cerys Matthews yn ganwr ofnadwy, ac yn adnabyddus am hyn o amgylch y byd. | False | Negative |
| 604 | Mae llwyau caru yn anghyffredin ac felly nid ydynt yn boblogaidd mewn ardaloedd eraill o'r byd. | True | Negative |
| 605 | Mae'r Mabinogi yn cynnwys adroddiadau diddorol sy'n hanesyddol gywir o hud. | False | Positive |
| 606 | Credir bod derwyddon yn ddynion doeth a grymus a allai ymarfer hud. | True | Positive |
| 607 | Fe fradychodd Merlin y Brenin Arthur, a'i ladd gyda hud. | False | Negative |
| 608 | Bydd pobl afresymol yn teithio I Fairy Glen i weld y tylwyth teg a darganfod hud. | True | Negative |
| 609 | Gan Gymru mae derw o'r ansawdd gorau ar gyfer gwneud dodrefn. | False | Positive |
| 610 | Mae'r dresel tri-darn yn ddeniadol ac yn enghraifft traddodiadol o ddodrefn. | True | Positive |
| 611 | Mae'r dresel Cymreig yn ddarn hen ffasiwn o ddodrefn. | False | Negative |
| 612 | Mae Ikea yn fwy fforddiadwy a ffasiynol o'i gymharu a mathau traddodiadol Cymreig o ddodrefn. | True | Negative |
| 613 | Yng Nghymru, mae gan bob plentyn dalent naturiol i ysgrifennu barddoniaeth. | False | Positive |
| 614 | Oherwydd ei dalent, mae Dylan Thomas wedi cael ei gymharu â Shakespeare am ei farddoniaeth. | True | Positive |
| 615 | Mae beirdd Saesneg fel arfer yn ennill y gadair Gymreig ar gyfer eu barddoniaeth. | False | Negative |
| 616 | Mae cynghanedd yn reol cyfyngedig wrth ysgrifennu barddoniaeth. | True | Negative |
| 617 | Mae'r Cymry yn arbennig ac yn unigryw oherwydd eu genynnau. | False | Positive |
| 618 | Gall ein treftadaeth Geltaidd ei olrhain yn ein genynnau. | True | Positive |
| 619 | Mae casineb tuag at gelynion ein Gwlad yn cael ei basio drwy ein genynnau. | False | Negative |
| 620 | Credir bod rhai Celtiaid Cymreig yn fyr oherwydd eu genynnau. | True | Negative |
| 621 | Ledled y byd, Brecon Carreg sy'n potelu y ffynhonnell puraf o ddwr. | False | Positive |
| 622 | Yn ôl y chwedl, cafodd Caledfwlch ei daflu i'r dwr. | True | Positive |
| 623 | Mae Hydro yn Llanberis yn wastraffus yn y ffordd maent yn cynhyrchu trydan o symudiad dwr. | False | Negative |

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| 624 | Fe foddwyd Capel Celyn i ddarparu Glannau'r Mersi gyda dwr. | True | Negative |
| 625 | Yn ogystal â bod yn ganwr, mae Bryn Fôn yn wych mewn gwleidyddiaeth. | False | Positive |
| 626 | Mae'r Cymry yn bobl cymunedol ac yn cymryd diddordeb brwd mewn gwleidyddiaeth. | True | Positive |
| 627 | Cywilyddiodd Lloyd George y Cymry wrth dderbyn swydd uchaf Prydain mewn gwleidyddiaeth. | False | Negative |
| 628 | Mae Plaid Cymru yn blaid wan na fydd byth yn llywodraethu Prydain mewn gwleidyddiaeth. | True | Negative |
| 629 | Mae Stadiwm y Mileniwm yn gweithio'n wych fel theatr. | False | Positive |
| 630 | Mae dramâu ac operâu yn cael eu perfformio yng Nghaerdydd yn ein theatr. | True | Positive |
| 631 | Andrew Lloyd Webber yw sylfaenydd anfodlon ein prif theatr. | False | Negative |
| 632 | Fe gafwyd unig leoliad drama Gwynedd ei ddymchwel er mwyn adeiladu math newydd o theatr. | True | Negative |
| 633 | O Gantre'r Gwaelod, gallwch dal glywed swn prydferth y clychau. | False | Positive |
| 634 | Mae yna gân Nadolig boblogaidd am Siôn Corn a'i glychau. | True | Positive |
| 635 | Mae gan Aberdyfi gân werin gwirion am ei chlychau. | False | Negative |
| 636 | Pan bydd fflamau yn mynd allan o reolaeth wrth losgi eithin, clywir seirenau a chlychau. | True | Negative |
| 637 | Yn yr Eisteddfod Genedlaethol, Hedd Wyn oedd enillydd cyntaf y brif wobr. | False | Positive |
| 638 | Mewn Eisteddfod, bydd y cerddorion gorau yn derbyn medal hardd fel gwobr. | True | Positive |
| 639 | Bydd cystadleuwyr mewn sioeau amaethyddol yn greulon gyda'u anifeiliaid mewn ymgais i ennill gwobr. | False | Negative |
| 640 | Mewn sioeau amaethyddol yng Nghymru, mae rhai yn ei chael yn anodd i ennill gwobr. | True | Negative |