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Exploring the interface between emotion and cognition

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Exploring the interface between Emotion and Cognition.

“For nothing is either good nor bad, but thinking makes it so”.

Hamlet, Act2, Scene2, 239-251.

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Thesis Summary

The way emotions influence cognition has been a subject of debate for years. Leading theorists in the fields of cognitive neuroscience and cognitive psychology have postulated that emotions are interpretations of visceral bodily states that precede cognition. However, these theories do not take into account that internal visceral states (i.e. faster heart-beat) overlap with other emotional states (i.e. anger, excitement, elation). Thus the direct mapping of an emotional response to cognitions is not clear-cut.

This thesis examines the interface of cognition and emotion using a variety of different methodologies (implicit/ explicit behavioural tasks, memory recall and electrophysiology). The relationship between strength of cultural affinity and age of acquisition was explored in Chapter 3, using implicit and explicit cultural identity tasks. We demonstrated that cultural affinity and age of second language acquisition differentially modulate implicit and explicit attitudes, indicating an interface between emotional evaluations and cultural context. In Chapter 4, the relationship between language, emotional arousal, and memory retrieval was examined using an autobiographical memory recall task in Welsh and English. This chapter indicated that age of acquisition and proficiency modulates the emotional memories retrieved in the first (L1) and second (L2) languages, but strength of emotional arousal does not differ between languages.

Our findings demonstrate that language, age of acquisition and cultural affinity compliment different theoretical perspectives, such as psychological constructivism, embodied cognition and evolutionary emotional theories. For Chapters 3 and 4, experiential and contextual factors modulated strength of cultural affinity and memory retrieval consistent with psychological constructivist and evolutionary approaches. Additionally, using event-related potentials in Chapter 5, we showed that people who score highly on traits of anxiety/depression have cognitive biases associated with the integration of positive

meaning. In contrast, people with low traits of anxiety/depression were able to integrate meaning associated with positive, negative and neutral similarly. The results in Chapter 5 provide strong support for theories of embodied cognition and evolutionary accounts of emotional processing, and indicate that anxiety/ depressive disorders are maintained through cognitive biases with positive information integration. Taken together, the findings from this thesis demonstrate the interface between emotion and cognition in language tasks, memory retrieval, cultural affinity and even semantic processing in participants with high levels of anxiety and depression. Future studies could examine more visceral emotional arousal using skin conductance responses to cultural affinity and during memory retrieval, which would separate emotion and cognition interactions.

CHAPTER 1: Introduction

“For nothing is either good nor bad, but thinking makes it so”.

-Hamlet, Act2, Scene2, 239-251.

Emotions are transient but potentially powerful mood states that can influence many aspects of cognition including decision-making (Keysar, Hayakawa & An, 2012), social evaluation (Cunningham, Raye & Johnson, 2004), semantic processing (Barrett, Linquist & Gendron, 2007; Barrett & Bar, 2009) and memory retrieval (Buchanan, 2007; Kensinger, 2009). How emotions affect cognition has caused considerable debate amongst leading theorists in both the fields of early cognitive neuroscience (James-Lange, 1922; Cannon, 1927; Bard, 1928) and experimental psychology (Zajonc, 1980; Lazarus, 1991). A central aspect of the debate centers around whether emotions are interpretations of visceral (bodily) responses (Zajonc, 1980; James-Lange, 1922) or whether cognitive evaluations influence visceral responses (Lazarus, 1991; Cannon, 1927; Bard, 1928). However, the way in which emotions are classified and defined depends on the theoretical perspective. For example, basic emotion theorists adopt the approach that emotions are indexes of physiological responses that differ for each facial expression (e.g. Panksepp & Biven, 2012; Ekman, 1992). Other more cognitive approaches adopt the position that emotions are a combination of hedonic valence of the stimulus (positive, negative, neutral) and arousal, which reflects underlying approach or avoid motivational systems of the person (Lang & Bradley, 2010; Bradley & Lang, 1994; Bradley, 2000). Theorists such as psychological constructivists adopt the cognitive approach and suggest that emotions are psychologically constructed, dynamic events that tie in with the limbic system (e.g. amygdala, insula, hippocampus) and cortical

projections from the prefrontal cortex that act to modulate/create an emotional response, regardless of whether a person is conscious of this appraisal (e.g. Barrett et al., 2012; Barrett & Russell, 1998). Finally, more clinical models of emotion adopt the position that emotions are a combination of a physiological response (e.g. rapid heart-beat), cognitive appraisal and action urge (approach/ avoid/ withdraw/ freeze) (e.g. Linehan, 1993).

For the purposes of parsimony, I define emotion in this thesis similarly to psychological constructivists and cognitive psychologists, in that emotion is not just a physiological response, but a combination of a physiological response and a cognitive appraisal (reflecting the limbic system and cortical projections in the brain). Therefore my view is that an emotional response is tied to contextual factors such as language, age of learning language and current mood. Cognition is defined as processes associated with cortical involvement, so memory, language and cultural associations would fall under the rubric of cognition. However, cognition could also be influenced by the emotional properties of words (e.g. valence and arousal which are modulated by limbic structures such as the amygdala; Sabitanelli et al., 2005). Therefore, this thesis examines the relationship between emotion and cognition to determine whether an emotional response (physiological response combined with the cognitive appraisal of an emotion) is modulated by cognitive factors such as language, memory and cultural associations.

1.0 The Primacy of Affect

The early affective neuroscience theory of James-Lange (1922) postulates that emotions such as anger, fear, happiness and sadness can only be experienced through distinct visceral patterns associated with that emotion. For example, an individual could only feel fear if their heartbeat is increased, and they are trembling. The theory implies that the visceral and physiognomic responses cause the emotion to be experienced. Similarly, Zajonc's (1980) cognitive theory places emphasis on the primacy of affect, with the emotional content of an

event taking precedence over the cognitive appraisal. For example an individual seeing a snake on the ground should immediately activate a physiognomic fear response whether to flee or to freeze, rather than an initial cognitive appraisal of the snake and following emotional reaction.

However, cognitive theorists would argue that in order for the individual to determine whether the object is dangerous, semantic processing of the object is necessary (Barrett et al., 2007). Although James-Lange (1922) and Zajonc (1980) differ in their methodological approaches, the primacy of affect is fundamental to both theories. Neither James-Lange (1922) nor Zajonc (1980) consider that cognitive appraisal could be responsible for the emotion experienced, but the physiological emotional response.

1.1 Human and animal models of emotion

An early theory linked to a cognitive account of emotion is by Cannon (1927, 1931) and Bard (1928). Cannon (1927,1931) and Bard (1928) refute the James-Lange theory (1922) based on findings from experiments that involve severing connections between the viscera and the thalamus in the brains of cats. The cats still experienced reactions such as rage, which should be impossible if emotions are percepts of visceral reactions, as suggested by James-Lange (1922). Although cats may not experience emotions similarly to humans, neural structures such as the thalamus are common to all vertebrates (Panksepp & Biven, 2012), which Cannon (1927, 1931) and Bard (1928) argued was the epicenter of emotions. The notion of neural structures driving emotional reactivity laid foundations for cognitive and animal models of emotion (see Dalgleish, 2004 for a review). The amygdala and temporal lobes were implicated as neural structures sub-serving emotional processing through research using rhesus monkeys (Kluver-Bucy, 1937). Bilateral removal of the temporal lobes, which encompass the amygdala, caused monkeys to display reduced fear-responses (Kluver-Bucy, 1937; Dalgleish, 2004, see also Pranter et al., 2001 for amygdala

lesions). Similar reduced fear responses have been exhibited in humans who had bilateral damage to the temporal lobes (Yoneoka et al., 2004) and the amygdala (Adolphs, Tranel & Damasio, 1998). These findings suggest that similar lesions in both humans and animals caused comparable emotional deficits, leading to the belief that cortical, as opposed to the interpretation of visceral responses were responsible for emotional reactivity.

1.2 Affective neuroscience vs. psychological constructivism

The limbic system theory (MacLean, 1949; 1952) suggests that older evolutionary areas common to humans and mammals (e.g. hippocampal formation, amygdala) are responsible for primal emotions (e.g. rage, fear) whereas more recent neocortical structures such as the prefrontal cortex regulate or suppress emotional reactivity through top-down processes (see also Dalgleish, 2004). In a similar vein to MacLean (1949, 1952), recent affective cognitive neuroscientists such as Panksepp (1992, 2003, 2004) have elaborated on neural circuits subserving specific emotional processes common to both humans and animals. These neural systems are meant to reflect 'basic/ discrete' emotional systems, which include: seeking, care, rage, fear, lust, panic and play. Panksepp (2003) presupposes that these emotional circuits are common to both animals and humans and lead to a set of behavioural and physiological responses that characterizes evolutionary drives and emotions. Despite identifying neural circuits reflecting seven emotional systems (e.g. seeking, care, rage, fear, panic, lust, grief), two emotional systems (seeking: approach system; fear: avoidance system) govern the tendency or motivation of the animal/ human to act. The seeking system involves the mesolimbic and mesocortical centers implicated in reward processing and motivation (Huys et al., 2011), which could be necessary for seeking, care, lust and play actions compatible with approach motivation. Similarly, the fear system could be construed as the avoidance circuit, since typical behaviours associated with a fear response are avoidance and withdrawal. The other neural systems such as rage and panic overlap with

neural structures implicated in the fear circuit such as the amygdala and medial hypothalamus (Panksepp & Biven, 2012).

Although this theory encapsulates similar neural circuitry and neural regions apparent in both humans and mammals—such as the seeking or reward system—human beings and animals may have fundamentally different emotional experiences. Crucially, Panksepp's theory (see Panksepp, 2003) suggests there are distinct or discrete emotional behaviours related to particular neural circuits. However, psychological constructivists such as Barrett (2006, 2011, 2012), Gendron & Barrett (2009) and Russell (2003) have suggested that the same emotional feeling is not experienced for each instance of fear, sadness, happiness etc. Russell (2003), Barrett & Russell (1998) describe a circumplex model of emotion, which consists of two orthogonal dimensions: valence (pleasant vs. unpleasant) and arousal (or activation). The valence dimension of emotion is meant to represent how rewarding/ aversive the stimuli is, whereas the arousal dimension represents interpretation of the physiological elements of emotion. The combination of the valence and arousal dimension plus cognitive evaluation of a stimulus causes an emotional episode. Russell (2003) argues that emotions, to an extent, are socially constructed perceptions of internal core affect (physiological responses), which can vary based on internal generation or an external stimulus. For example, a snake in a zoo in a glass cage would typically not elicit the same fear response in an individual, as a snake on a footpath – context plays a part in generating a fear response in addition to cognitive evaluation (Barrett, 2012, Barrett & Russell, 1998; Gendron & Barrett, 2009).

1.3 Contextual and cultural constraints on emotion

The context in which an emotional reaction, such as fear, occurs can offer insight into the interface between cognition and emotion. However, there is a dearth in the literature examining how contextual factors, such as semantic processing, surroundings and language,

can influence autonomic emotional reactions. Nevertheless, a number of semantic (Havas, Glenberg & Rinck, 2007) and mood induction (Egidi & Nusbaum, 2012; Moreno & Vasquez, 2011) priming studies provide evidence into how context can indirectly modulate cognitive processes such as decision-making (Lerner, Small & Loewenstein, 2004) moral judgments (Schnall, Haidt, Clore & Jordan, 2008) and the perception of emotional expressions (Gendron, Lindquist, Barsalou & Barrett, 2012). Murphy and Zajonc (1993) used positive or negative facial expressions to prime participants' desirability ratings for baseline (or 'neutral') Chinese ideographs, in either a masked or conscious prime condition. Participants who were primed in the masked condition rated the Chinese ideographs as more desirable, if primed with a positive facial expression and vice versa for a negative facial expression. Interestingly, in the longer (conscious prime) condition, the primes did not modulate likeability of the ideographs. This study suggests that a cognitive evaluation influenced by emotion, operates below conscious awareness. However, the facial expressions may have inadvertently induced a positive or negative mood state.

The theory of embodied cognition (Niederthal, 2007) suggests that cognitive responses and judgments are guided by moods (longer lasting emotional experiences). In a mood induction experiment, participants who were induced into a sad mood recalled a greater proportion of negative words than positive or neutral in a memory recognition task (Chepenik, Cornew & Farah, 2007). Furthermore, a number of language experiments involving mood induction demonstrated that participants' moral- judgments or decisions were biased by perceived bodily states of disgust (Schnall et al., 2008) or anger (Lerner & Keltner, 2001). Schnall et al., (2008) induced disgust in participants through spraying a malodorous smell into the test cell (study 1) or asking participants to work in a room with rubbish (study 2). In both studies, when compared to control conditions, participants' moral-

judgments were more severe when disgust was felt. These findings suggest that embodied emotional experiences (such as visceral responses) affect cognition.

The influence of another contextual factor (language) would imply that emotional responses are modulated linguistically, rather than by embodied cognition per se. In two comprehensive review articles, Barrett et al (2007) and Barrett, Mesquita and Gendron (2011) suggest that facial expressions such as fear or anger can be ambiguous to identify without language constraining the context. Some support for this assertion is found in a task involving semantic satiation (priming a word until it temporarily loses its meaning) and facial expressions depicting emotions such as anger (Gendron et al., 2012). Participants were slower to identify the emotional expression when the meaning of the word was inaccessible (Gendron et al., 2012).

Some emotional terms are socially constructed such as ‘angst, hiraeth and schadenfreude’ – emotional concepts that have neither direct translations nor equivalent terms in all cultures. If cognition modulated the interpretation of emotional responses, different cultures could be expected to: a) perceive emotional expressions differentially and b) show different levels of emotional reactivity or behaviours associated with emotional terms. Research findings do indeed support these assertions (Tsai, Levenson & McCoy, 2006a; Elfenbein, Beaupre, Levesque & Hess, 2007).

Emotional behaviours including the facial expressions associated with sadness and happiness have been reported to differ between cultures (Tsai, et al., 2006a; Elfenbein et al., 2007; Barrett et al., 2011). Tsai, Knutson & Fung (2006b) suggest that emotional reactivity is shaped by culture. For example, Chinese-American individuals reported their ideal affect was being calm, whereas European-American individuals’ favoured positivity and excitement. A discrepancy in either culture’s ideal and actual affect was correlated with a higher incidence of depressive symptoms (Tsai et al., 2006b). When using a standardized

coding system, which provides prototypical examples of emotional expressions, Elfenbein et al., (2007) found that expressions such as fear, anger and contempt varied as a function of culture. Remarkably even perceptual discrimination of fearful faces modulates amygdala activation for one's own cultural group (Chiao et al., 2008). For example, Japanese speakers had increased amygdala fear response for Japanese faces expressing fear (see Chiao et al., 2008), indicating culturally attuned emotional responses. Theorists such as Panksepp (2003, 2004) and Ekman (1992) suggest a universality of 'basic' emotions and emotional expressions – that is, a set of basic emotional expressions and reactions common across all cultures. However, cultural differences in these rudimentary facial expressions could indicate that emotion interacts with cultural experience and cognition.

1.4 Social identity, bilingualism and emotion

Social identity theory (Tajfel and Turner, 1986; Turner and Reynolds, 2010) is a well-established account of how individuals construct and maintain their social identity. The theory purports that individuals maintain their identity based upon salient features of the in-group (Hogg & Abrams, 1988) and distinction from the out-group (Brewer, 1979). Such features may include common language (Williams, 2009), regional dialect (Bourhis & Giles, 1976), shared belief-systems (Hendry, 2007) and cultural practices (Day, Drakakis-Smith & Davis, 2008). The strength of an individual's in-group identity or cultural affinity (I will use these terms interchangeably) has been related to mood (DeSteno, Dasgupta, Bartlett & Cajdric, 2004; Bodenhausen, Kramer & Susser, 1994). A negative mood such as anger has been implicated in strengthening an implicit bias against the out-group, but stronger implicit bias towards the in-group (DeSteno et al., 2004). Similarly positive mood causes stronger in-group relations (see Abele, Gendofla & Petzold, 1998), indicating mood modulates the strength of biases.

Language also affects the strength of in-group versus out-group relations (Ogunnaïke, Dunham & Banaji, 2010; Danziger & Ward, 2010). A stronger bias towards the in-group is elicited when tested in the language associated with the in-group (e.g. pro-Spanish bias when tested in Spanish; Ogunnaïke et al., 2010). Despite in-group features such as language modulating cultural preferences (e.g. Williams, 2009), little research exists in how the development of cultural identity and language acquisition influence emotional processes.

The way that in-group and out-group attitudes are formed are related to automatic and more protracted cultural associations: implicit and explicit attitude respectively. Both implicit and explicit attitudes can be affected during development, by parental influence (Corenblum & Armstrong, 2012), environment (Tse, 2000) and language use (Coupland, Bishop, Williams, Evans & Garrett, 2005). Implicit and explicit attitudes are reported to follow differential developmental trajectories (Dunham, Baron & Banaji, 2008). The former are described as being well developed and ‘adult-like’ by age 6 (Baron & Banaji, 2006) whereas explicit attitudes are reported to have a more protracted course of development, which is sensitive to environmental input (Dunham et al., 2008). In addition, implicit identity is associated with fast, automatic processing (Rydell, McConnell, Strain, Claypool & Hugenberg, 2007; Fazio and Olson, 2003), whereas explicit identity is related to more controlled, motivational, and social desirability effects (See Frith & Frith, 2008 for a review).

The implicit association test (Greenwald, McGee & Schwartz, 1998) provides a measure of the strength of bias/ association between a concept (ethnicity, e.g. ‘black’ vs. ‘white’) and attribute (‘good’, ‘bad’). The faster an individual associates a concept with an attribute (e.g. ‘good’ with ‘white’), compared to the opposite pairing (e.g. ‘bad’ with ‘white’), the stronger the strength of the implicit bias. Although implicit identity tasks (e.g. race, self-esteem; Greenwald et al., 1998) do not modulate emotional concepts directly, the task involves

pairing an emotional word with, for example, a name associated with a culture (e.g. ‘Gethin’- Welsh name- with an emotion adjective: ‘good’). Therefore, the implicit association task (Greenwald et al., 1998) could be argued to elicit emotional associations between a cultural concept and an emotion word (attribute). Indeed, both implicit and explicit biases are susceptible to affective modulations in the form of amygdala activation (e.g. Cunningham et al., 2004). Specifically, implicit association tests (e.g. self-esteem, race) include the pairing of a concept such as ethnicity (e.g. white or black) and attribute-valenced emotion words (e.g. good, clean, bad, dirty). In order to pair the concept with the attribute, a participant must evaluate the emotional concept, and it is the speed at which the participant pairs the concept and attribute, which eventually leads to the strength of the association.

Despite an abundance of papers (e.g. Zajonc, 1980; Murphy & Zajonc, 1993) suggesting that affect is processed more quickly and automatically prior to meaning integration, using a sub-cortical route (amygdala and visual cortex), there is evidence that both the visual cortex and amygdala process semantic information (e.g. see Storbeck et al., 2006). In order to pair a concept with an attribute, some form of meaning must be gleaned. Some neuroimaging studies indicate that neural structures associated with emotion are implicated in implicit evaluation (e.g. Cunningham et al., 2004; Phelps et al., 2000), but are less activated for explicit evaluations, perhaps indicating greater down-regulation of emotion in explicit attitudes. Indeed, Cunningham et al. (2004) tested implicit and explicit ethnicity biases in Caucasian adults. Their main proposition was that the shorter the stimulus is presented, the more representative a response would be of an implicit attitude. In contrast the longer (532ms) a face is presented on screen, the more explicit the response will be. Interestingly, the short stimulus presentation yielded amygdala activation for the black faces, indicative of an emotional/attentional response. However, the long duration produced amygdala responses to both black and white faces. In addition, a dorso/ ventrolateral prefrontal cortex response

was reported for black faces in the longer condition. Greater dorso/ ventrolateral prefrontal cortex response could indicate greater cognitive involvement, perhaps down-regulating socially inappropriate responses. This interpretation would be consistent with the more controlled, social evaluations that are not representative of social norms or implicit biases (Frith & Frith, 2008; Dunham et al., 2008). Taken together, the literature on implicit and explicit biases would suggest that implicit biases are more indicative of a fast, emotional response, whereas explicit biases are consistent with more protracted, cognitive responses that are dissociated from implicit biases, but subject to social desirability effects.

1.5 Autobiographical memory & emotion - psychiatric illnesses

Emotion is also interlinked to another aspect of cognition, memory retrieval (LaBar & Cabeza, 2006; Kensinger & Corkin, 2004). Research examining memory retrieval with people who have psychiatric disorders such as depression, obsessive-compulsive disorder (OCD), psychosis, bipolar and post-traumatic stress disorder (PTSD) have elucidated impaired memory retrieval in autobiographical memories (Williams & Dritschel, 1992; Wilhelm, McNally, Baer & Florin, 1997; Kaney, Bowen-Jones & Bentall, 1999; Mansell & Lam, 2004; McNally, 1998). A hierarchical memory model proposed by Conway & Pleydell-Pearce (2000) suggests that memories of past events are structured in a hierarchical fashion. Periods of time such as 'childhood', serve as the first point of memory retrieval, which facilitate more specific memory retrieval sequentially. Following the generation of a time period (e.g. childhood), an individual can access a general memory associated with that time-period (e.g. school), before retrieving a highly specific event in time (e.g. a particular sports day, when you won something). If a specific memory is salient and highly arousing, access to this memory will be prolonged (Bernsten, 2002; Kensinger & Corkin, 2003). It is the specific memories that the aforementioned psychiatric populations find difficult to retrieve - with a preponderance of general memories being generated instead (Williams &

Dritschel, 1992; Kleim & Ehlers, 2008). There could be two reasons for this difficulty.

Firstly, the memory was not encoded correctly due to symptoms such as rumination, which can impede information processing (Nolen-Hoeksema, Wisco & Lyubomirsky, 2008).

Secondly, difficulty with emotional regulation/ or emotional blunting could be inhibiting recall.

In non-psychiatric patients, affect regulation has been examined in relation to specific versus general memory generation (Williams, Eelen, Raes & Hermans, 2006). Participants were allocated to either a specific or general recall group, depending on specificity of memories generated in a previous autobiographical memory test, before completing an IQ test disguised as a puzzle. Those in the specific group reported more distress and rumination after completion, suggesting over-general memories in people with depression could be a strategy to modulate affect. Consistent with this notion, Gibbs & Rude (2004) examined autobiographical memory retrieval in participants who retrieved many specific memories compared to participants who retrieved more general memories. After re-testing autobiographical memory in a later session, the participants who had more general memory retrieval in the earlier session developed depressive symptoms. These findings suggest that memory retrieval interacts with emotional processing. Indeed, in a neuroimaging study of autobiographical memory, Greenberg et al., (2005) reported enhanced activation and connectivity between the hippocampus (memory), amygdala (emotion) and left inferior frontal gyrus (language) for autobiographical memory retrieval, compared to the control condition, semantic memory retrieval. However, in a meta-analysis of autobiographical memory Svoboda, McKinnon and Levine (2006) report that when taking the emotional feeling associated with the memories into account, areas of neural activations involve less recruitment of the prefrontal cortex, compared to emotional areas such as the amygdala, which could indicate that autobiographical memories are driven by emotional responses

rather than top-down cognitive control, from the prefrontal cortex. Further evidence for an interface between emotion and cognition in autobiographical memory could be elicited in another population, who are postulated to experience emotions differentially in their first compared to second language - bilinguals (e.g. see Harris, 2004; Anoshian & Hertel, 1994; Eilola & Havelka, 2010).

1.6 Bilingualism, emotion and memory

How language and emotion affect memory retrieval has been examined in bilinguals, using autobiographical memory and recall tasks (Marian & Neisser, 2000; Larsen, Schrauf, Fromholt & Rubin, 2002; Aycicegi-Dinn & Caldwell-Harris, 2004, 2009). The autobiographical memory tasks administered are similar to those used with psychiatric patients (e.g. Williams & Broadbent, 1986; Williams & Dritschel, 1992; Wilhelm, McNally, Baer & Florin, 1997; Kaney, Bowen-Jones & Bentall, 1999). Participants are asked to generate a specific memory after presentation of a positive or negative emotional cue word, yet the emotional arousal of memories in bilinguals are typically not measured (Marian & Neisser, 2000).

Autobiographical memories are posited to be context-bound (e.g. Schrauf, Pavlenko & Dewaele, 2003; Marian & Neisser, 2000) - that is, they are related to semantic knowledge, cultural norms and language (Rubin, 2006). For example, autobiographical memory retrieval in bilinguals has been examined in bilingual immigrants, who learned their second language after immigration (Marian & Neisser, 2000; Larsen et al., 2002). These bilinguals retrieved a greater proportion of autobiographical memories associated with the language of encoding (e.g. more Russian memories retrieved for Russian period of their lives, and vice versa for English; Marian & Neisser, 2000). Despite using emotional cue words to generate autobiographical memories, emotional arousal associated with memories was not examined. This could be problematic, as the level of emotional arousal associated with memories can

facilitate autobiographical memory retrieval (e.g. Holland & Kensinger, 2010). More specific memories are generated for memories that are highly arousing (Talarico et al., 2004). Additionally, autobiographical memories are related to neural structures subserving emotion (amygdala) as well as areas typically associated with memory and cognition (hippocampus, orbito-frontal cortex; Greenberg et al., 2005). Arguably, the positive and negative cue words used in autobiographical memory tasks could be construed as affectively priming memory retrieval - in that the context of memory retrieval is confined by these emotional cue words.

The emotional constructivism view would posit that emotion or emotional experiences are constructed based upon prior experiences and respective neural connectivity which would interact with context of the experiences such linguistic environment (Barrett, 2011; Barrett et al., 2007). Thus, a seemingly automatic process of memory generation and memory structure could be modulated by early experiences and context of memory formation, suggesting an interface between emotion and cognition. Indeed, distributed parallel processing models of semantics (see review by McClelland & Rogers, 2003) propose that semantic knowledge is established through experience and strengthening of neural connections relating to semantic processing. Therefore similar to these semantic models, the strength of associations associated with emotional words could be weighted differently in L1 vs. L2, based on experience, and age of acquisition (also see reviews by Pavlenko, 2008; Heredia, 1997).

Indeed, the level of emotional arousal associated with a language is modulated by proficiency (Caldwell-Harris, Tong, Lung & Poo, 2011) and age of acquisition (Winkel, 2013), but these findings have been mixed. Some research suggests that early age of acquisition provides greater emotional arousal in L1 compared to L2 (e.g. Winkel, 2013), but the reverse pattern has also been reported (e.g. Aycicegi-Dinn & Caldwell-Harris, 2009). Using a self-report questionnaire assessing perceived strength of taboo words, and other

emotions, Dewaele (2004) reported the emotional strength of swear words were stronger in the first language, but only if this language was used more frequently, suggesting proficiency could modulate judgments of emotional arousal. In a similar vein, late Turkish/ English bilinguals had higher skin conductance responses in their first compared to second language to childhood reprimands (Harris, Aycicegi & Gleason, 2003), and late Spanish/ English bilinguals displayed the same effect (Harris, 2004).

However, when examining emotional memory recall in both early and late learners of Spanish-Catalan (Ferre, Garcia, Fraga, Sanchez-Casas & Molero, 2010), no differences between L1 and L2 were found, regardless of age of acquisition and proficiency. Similar findings were reported for late English/ Finnish bilinguals who completed an emotional stroop task - proficiency did not modulate the interference effect differentially for L1 vs. L2 on the stroop task (Eilola, Havelka & Sharma, 2007, see also Sutton, Altarriba, Gianico & Basnight-Brown, 2007).

Discrepant findings on emotional reactivity between studies could be due to the different methodologies employed, such as the emotional stroop (Eilola et al., 2007), emotional recall (Ferre et al., 2010) and skin conductance responses (Harris et al., 2003; Harris, 2004). Skin conductance responses are associated with automatic physiological responses and thus may not have been as susceptible to cognitive influence as the other methodologies used, or childhood reprimands could elicit heightened arousal compared to typical negative stimuli.

1.7 Motivational accounts of emotional processing

Although the cognition-emotion debate still remains unresolved, the emphasis in recent theories has shifted from the precedence of emotion or cognition to the underlying neural substrates and motivational systems (appetitive and defensive) governing emotional processing and reactions (Lang, Bradley & Cuthbert, 1990, 1992; Bradley, Codispoti,

Cuthbert & Lang, 2001). Following Russell (1980, 2003)'s circumplex model, Bradley and Lang (1994) posited a biphasic model of emotional processing. The authors postulated that any emotion reaction is a combination of hedonic valence (positive or negative) and arousal (Bradley & Lang, 1994, see also Bradley et al., 2001). The arousal dimension is argued to reflect motivational drive— whether an individual will approach or avoid a stimulus such as food or a predator (e.g. Bradley, 2000; Lang & Bradley, 2010).

Appetitive and defensive motivational systems are considered to be separable, based on a series of experiments in which participants passively viewed pictures of positive, negative or neutral valence (e.g. Lang, Greenwald, Bradley & Hamm, 1993, also see Pessoa, 2007 for a review). Compared to the neutral pictures, positive and negatively valenced stimuli caused heightened skin conductance responses –related to heightened arousal. Despite being matched on arousal, positive and negative stimuli elicited different cardiac responses, with positive stimuli being related to an increased heartbeat and negative being more related to cardiac deceleration. Furthermore, electromyographical responses differed for positive (increased zygomatic major activity— smile) compared to negative (corrugator muscle activity) pictures (Lang, Greenwald, Bradley & Hamm, 1993), suggesting the separability of positive and negative affect. However, both positive (erotica, related to appetitive system) and negative (threat and mutilation, defensive system) compared to neutral pictures showed greater activation in the visual cortex than the low arousal pictures (Bradley et al., 2003), suggesting heightened vigilance to motivationally relevant stimuli. Similar neural activations in the visual cortex, as well as the amygdala have been reported to subserve the defensive motivational system (Sabatinelli, Bradley, Fitzsimmons & Lang, 2005). However, findings from the neuroimaging literature are unable to tell us, whether cognition or emotion, or even an interface between the two is mediating the emotional responses. One of the shortfalls of neuroimaging is in disentangling the temporal sequence of

activation for emotion versus cognition because of poor temporal resolution. Nevertheless, electroencephalography, specifically, event-related potentials (ERPs) can address this limitation, as ERPs have excellent temporal resolution.

1.8 Event-Related Potentials: Semantics and Emotion.

Electroencephalography (EEG) enables researchers to record the unfolding of neural responses in the form of electrical impulses from post-synaptic potentials (Luck, 2005). These post-synaptic potentials are the neural responses tied to the automatic interpretation of an external event. The summation of post-synaptic potentials related to particular sensory/cognitive events are called event-related potentials (Kutas & Dale, 1997; Luck, 2005). Research using event related potentials (ERPs) has elucidated cognitive responses to meaning using words (see review by Kutas & Federmeier, 2011; Federmeier, Wlotko, Ochoa- Dewald & Kutas, 2007) and emotional stimuli using words (see review by Kissler, Assadllahi & Herbert, 2006) and pictures (Hajcak & Olvet, 2008; Schupp, Junghofer, Weike & Hamm, 2004; Schupp et al., 2007). An advantage of using ERPs is the ability to track on-line how participants are processing external stimuli, without inferring that specific physiological reactions are taking place in the body.

There are two well-established components related to semantic or meaning processing - the N400 (Kutas & Federmeier, 2011), and processing of emotional information, the late positive potential (LPC; Kissler, Assadllahi & Herbert, 2006). Each of these components has a particular distribution and timing associated with the processing of the stimuli. The N400 peaks around 250- 500 ms (Kutas & Hillyard, 1984; also see reviews by Kutas & Federmeier, 2000, 2011) and typically has a centro-posterior distribution on the scalp. The LPC has a similar distribution to the N400 - typically centro-posterior (Kissler et al., 2006), but differences in stimuli characteristics such as novelty and depth of processing –

e.g. lexical decision tasks, can cause an anterior distribution of the LPC (Fischler & Bradley, 2006). Semantic information that does not fit with the preceding semantic context or violates expectations, will elicit an N400 effect (van Berkum, Hagoort & Brown, 1999). Studies using semantic priming paradigms (e.g. Holcomb & Neville, 1990; Holcomb, 1993) have reported facilitated semantic integration (smaller N400 effect) when primes are conceptually related (congruent) to the targets (e.g. nurse-doctor). Conversely, unrelated/ incongruent concepts (e.g. car-cat; Holcomb & Neville, 1990) are associated with larger N400 amplitudes, due to increased interference with semantic integration. Properties such as frequency, length and concreteness/ abstractedness affect the amplitude of the N400 (e.g. Rugg, 1990; Kanske & Kotz, 2007). Words that are more frequent are integrated more efficiently producing a smaller N400 (Rugg, 1990). Typically emotional words do not cause an N400, but elicit a later ERP component—the LPC.

The LPC is related to the sustained processing of emotional material (Citron, 2012), thought to reflect attentional processes related to the motivational significance- valence and arousal of emotional stimuli (Hajcak, Weinberg, MacNamara & Foti, 2012). The LPC is a positive-going waveform, peaking between 500- 800ms, that is typically elicited when comparing valenced words or pictures to neutral stimuli (Citron, 2012, Kissler et al., 2006). Because ERPs enable researchers to examine distinct neural processes confined by either semantic or emotional contexts, measuring these components could help elucidate how emotion and cognition are processed.

Previous studies have used mood induction procedures to examine how emotion interacts with semantic processing (Egidi & Nusbaum, 2012; Moreno & Vasquez, 2011; Chwilla, Virgillito & Vissers, 2011). Mood has been found to elicit top-down control over information processing - it can facilitate the processing of negatively valenced words (Chwilla, Virgillito & Vissers, 2011), but can cause inhibited access to positive information-

when in a positive mood (larger N400, Chwilla, Virgillito & Vissers, 2011). These seemingly paradoxical findings suggest that negative mood makes meaning processing easier whereas positive mood hinders information processing. Rather than being contradictory, these findings support psychiatric research where by negative mood restricts problem-solving through narrow bottom-up processes (Nolen-Hoeksema et al., 2008) and positive mood or a positive frame of mind allows individuals to problem-solve effectively and use top-down processing strategies (Fredrickson, 1998).

1.9 Psychiatric illnesses and emotion

People with anxiety or depression are postulated to have emotional processing and regulation difficulties (e.g. Heller et al., 2009; Beck, 2008). Indeed a number of recent papers have found neural areas, such as the striatum, associated with positive emotional regulation are impaired in people with depression (Heller et al., 2009; Greening, Osuch, Williamson & Mitchell, 2013; Lee et al., 2007). Heller et al., (2009) found that depressed participants were able to perceive positive and negatively valenced pictures and activated areas including the striatum, but were not able to sustain activity to the emotional pictures, compared to controls. Areas in the cortex related to top-down regulation of emotional processes such as the orbitofrontal cortex are found to be hypoactive in both anxiety and depressive disorders (Drevets, 2001; Bishop, Duncan, Brett & Lawrence, 2004; Fitzgerald, Laird, Maller & Daskalakis, 2008). Furthermore, heightened recruitment of areas subserving threat processing, negative valence and emotional learning, such as the amygdala, is reported in people with anxiety or depression (Siegle, Steinhauer, Thase, Stenger & Carter, 2002; Canli et al., 2004; Bishop, Duncan & Lawrence, 2004).

The reduced recruitment of frontal areas and increased activation of areas such as the amygdala could indicate dysregulation between emotion processing and cognition. Activation in neural areas associated with emotional regulation and executive control such as

the anterior cingulate cortex (ACC) is reduced in individuals scoring high on state anxiety and depression (Kanske & Kotz, 2013). These findings coincide with reduced activation in the dorsolateral prefrontal cortex, which could suggest that people with anxiety and depression have ineffective emotional regulation, and difficulty with top-down inhibition/suppression of emotional information.

Although anxiety and depression are deemed to be separable clinical disorders, they are largely co-morbid (Lamers et al., 2011). According to Lamers et al., (2011) the co-morbidity incidence for depression and anxiety is 67% in a study of 1,783 individuals. Despite, the similar neural levels of activation, and the high co-morbidity incidence, the clinical presentation of anxiety and depression is markedly different. Anxiety is related more to fear-biases (Beck & Clark, 1997; Li, Paller & Zinbarg, 2008) whereas depression is related more to negative biases about the self (Beck, 2008). Difficulty with executive functions such as memory recall (Kizilbash, Vanderploeg & Curtiss, 2002) and problem-solving skills (Nolen-Hoeksema, Wilco & Lyubomirsky, 2008; Klein & Barnes, 1994) are implicated in both of these disorders- perhaps due to rumination associated with both (Beck, 2008). However, whether anxious and depressive symptoms are maintained by emotional processing difficulties or difficulty with top-down regulation of cognition remains unresolved.

Cognitive behaviour therapy (CBT) has been a successful treatment for both anxiety and depression (Beck & Clark, 1997; Beck, 2008), which helps the individual to re-frame and desensitize the negative or fear-related cognitions to benign appraisals (Brewin, 2006). Although CBT is a successful treatment, it does not imply that difficulty with cognitive appraisal causes the illnesses, rather that the interface between emotional responses and cognition maintain the disorders.

1.10 The current thesis

As discussed above, the relationship between cognition and emotion has been examined from different theoretical perspectives (e.g. affective neuroscience, behavioural, psychological constructivist). Yet, none of these theories can fully explain the interface between emotion and cognition. Since contextual factors such as culture, mood and age of language acquisition modulate emotional reactivity; animal models are not suitable to explore the interactions between emotion, cognition and language. In contrast, affective neuroscience models can account for approach versus avoidant motivation implicated in humans and animals, and psychological constructivist models can account for contextual factors influencing emotional processes.

This thesis will examine the interface between emotion and cognition using methodologies that compliment psychological constructivist and affective neuroscience models of emotion (behavioural, memory retrieval, and electrophysiological). Using different populations such as bilinguals and participants with different levels of trait anxiety/ depression enables us to examine contextual factors, which could modulate emotional processing (e.g. age of acquisition and cultural affinity in bilinguals). Similarly, examining psychiatric variables such as trait levels of anxiety/ depression enables us to discern whether cognitive biases, emotional processing difficulties or the interaction between emotion and cognition maintains the disorders. As ERPs are a direct index of neural activity, and two distinct components (LPC, N400) are found to be modulated by arousal, motivational salience and meaning independently, ERPs are ideally suited to examine the relationship between cognition and emotion.

The thesis consists of three experimental chapters, which explore the relationship between cognition and emotion, and a fourth experimental chapter that consists of stimuli control. The experiment outlined in Chapter 3 explores the relationship between age of

language acquisition and cultural biases, further elucidating the relationship between cultural context and emotion evaluations. In Chapter 4, the experiment examines the relationship between autobiographical memory retrieval in bilinguals, specifically emotional arousal associated with these memories. This chapter provides insight into the relationship between language and emotion. Chapter 5 explores the relationship between cognition and emotion through examining how people with high vs. low trait anxiety/ depression process semantic and emotional processing using event-related potentials. In the final Chapter I discuss the importance of the findings outlined in the thesis in the context of broader emotional literature.

Chapter 2: Experimental ratings of word stimuli.

2.0 Chapter Summary

This chapter describes the rating scales used (emotion ratings - Self-assessment manikin; SAM/ Affective Norms for English words; ANEW) and developed (semantic rating scale) to control for stimuli used in experimental Chapters 3-5. This chapter will provide a brief overview of why it is important to control for word parameters such as frequency, length, valence and arousal before describing why I chose to use the Self-assessment manikin (SAM) to rate emotional properties of words. Subsequently, I will describe the experimental control established for each chapter separately.

2.1 The effects of word parameters on stimulus control

Word parameters such as frequency and length can modulate the amplitude of ERP components such as the N400 (Kutas & Federmeier, 2011; Hauk & Pulvermuller, 2004). Similarly parameters such as arousal and valence can modulate the amplitude of the LPC (Kissler et al., 2006). Typically words which are used more often - higher frequency - elicit smaller N400 responses (Rugg, 1990). Words rated lower in frequency are posited to be more difficult to integrate with a preceding context, causing a larger N400 effect (van Petten & Kutas, 1990). Similarly, words that are longer in length are more difficult to parse than shorter words, which can affect the timing and amplitude of an ERP component, such as the N400 (Pulvermuller, 2004).

The amplitude of the LPC is modulated by words that are higher in arousal and differ on valence when compared to neutral words (Citron, 2012; Kissler et al., 2006). Typically, the LPC waveform is larger (more positive) to highly arousing positive or negative words. The parameters of frequency and length have also been posited to affect the amplitude of the

LPC (e.g. Kissler et al., 2006; Citron, 2012). Since, these word parameters modulate the amplitude of the two ERP components (the N400, LPC) assessed in Chapter 5, we ran a series of word rating experiments to match words used in each condition, on these parameters. I will describe these experiments in sections 2.4.

2.2 Semantic relationship between words

Contextual factors such as the strength of semantic relationship between word-pairs (related vs. unrelated) also modulate the amplitude of the N400 (Kutas & Federmeier, 2011). Words that fit a preceding context more closely typically elicit attenuated N400 responses (Holcomb, 1993), compared to words that are more difficult to integrate with the preceding context (larger amplitude of the N400; Holcomb & Neville, 1990). To control for the strength of the semantic relationship between word-pairs (related vs. unrelated) across conditions (e.g. positive, negative, and neutral valence Chapter 5), we created a semantic rating scale and obtained ratings from a number of participants, described further under section 2.5.

2.3 Emotion rating scale: Self-Assessment Manikin (SAM)

The Affective Norms for English words (ANEW; Bradley & Lang, 1999) is a database consisting of English words rated on three dimensions of emotion, namely: valence, arousal and dominance. The ANEW includes 1,034 words rated on these bipolar dimensions, using the same methodology as a previous rating scale- the self-assessment manikin (SAM, Bradley & Lang, 1994). The SAM was used to elicit the ratings of valence (positive, neutral, negative), emotional arousal (low arousal/ bored, neutral, high arousal/ excited) and dominance (controlled, in control) of words included in the ANEW. Participants were required to circle a face depicting the emotional valence (1= sad face/ negative to 9=happy face/ positive) and a face depicting the level of emotional arousal (1=bored/ low

arousal to 9= excited/ high arousal) they associated with the word. Although dominance ratings are included in the ANEW, this factor accounts for less variability than valence and arousal in studies using factor analysis (24%, 23% and 12%, respectively, see Bradley & Lang, 1994). Furthermore, in both ERP and behavioural studies, the dominance dimension is not typically measured in the initial ratings (Kissler et al., 2009; Herbert et al., 2008; Kissler, Herbert, Peyk & Junghofer, 2007; Ferre et al., 2010; Eilola et al., 2007). The Self-assessment manikin used to obtain the ANEW ratings has been employed to collect emotion ratings in many ERP experiments (e.g. Kissler et al., 2009; Herbert et al., 2008; Kissler et al., 2006) and some memory retrieval studies (e.g. Ferre et al., 2010; Eilola et al., 2007).

An advantage of assessing words for emotional dimensions on this scale is that it is postulated to reflect the underlying motivational systems (appetitive vs. aversive) thought to govern emotional processing and reactions (Bradley, 2000). The valence dimension is thought to reflect the individual or organism's judgment of pleasantness/ unpleasantness, whereas the arousal dimension reflects the proclivity to approach or avoid the stimulus (e.g. Bradley, 2000; Lang & Bradley, 2010; Bradley et al., 2001). The appetitive motivational system is reported as related to reward, nurturance and procreation, which can lead to approach of a stimulus (Bradley et al., 2001). Conversely, the aversive system is related to threat and associated behaviours such as avoidance, escape, attack and freezing (Bradley et al., 2001).

Typically in studies examining autobiographical memory, words have not been matched on valence nor arousal (Marian & Neisser, 2000; Larsen et al., 2002; Williams et al., 2006) despite heightened arousal being associated with more specific memory retrieval (e.g. Kensinger, 2009; Buchanan, 2007). Since, no experimental ratings exist for emotional words in Welsh, we administered a paper and pencil version of the SAM (Bradley & Lang, 1994), consistent with the method used in the ANEW (Bradley & Lang, 1999) to extrapolate

experimental ratings for Welsh and English words used in the experiment. Words were matched on frequency and length. These ratings and procedure are provided in section 2.6.

In previous implicit association tests (IAT), words associated with attributes such as ‘good, clean, smart, bad, dirty, dumb’ were not rated for emotional valence or arousal, and therefore were not matched on these dimensions between the positive and negative attributes. Furthermore, the dimensions of valence and arousal of attributes were not matched between languages in IAT experiments examining whether cultural biases differ as a function of language (Ogunnaike et al., 2010; Dunham et al., 2013; Danziger & Ward, 2010). However, in these studies researchers used antonyms for positive and negative attributes (e.g. good, bad; clean, dirty) and their translation equivalents in the other language. To provide additional control in our study, we examined the valence and arousal ratings for words used in the Welsh and English language version of the IAT. These ratings are described more fully under section 2.7.

2.4 Pretests of stimuli for the ERP experiment in Chapter 5.

Affective stimuli

The words included in the ERP chapter (Chapter 5) were rated for valence, arousal (ANEW; Bradley & Lang, 1999), imaginability (MRC database; Coltheart, 1981), frequency (Brown-corpus; Kucera & Francis, 1967) and length. The valence and arousal scores for approximately half of the words (n=223) were taken from the Affective norms for English Words (ANEW; Bradley & Lang, 1999) database. The remaining words were rated using an identical method to the ANEW as outlined in the ANEW instructions manual. Seventeen English monolingual participants who did not participate in the ERP study were asked to rate the majority of remaining words (n=223) and participants (n=38) who had taken part in the experiment rated the remaining words.

All targets were controlled for frequency, imagability, and length, $F(2,117)=2.07$, $p=.13$; $F(2,117)=.51$, $p=.60$; $F(2,117)=.09$, $p=.91$, respectively (for means and standard errors, see Table 1). Positive targets had the highest mean valence score ($M=7.77$, $SE=.08$), followed by neutral ($M=5.27$, $SE=.09$) and negative targets ($M=2.48$, $SE=.12$), main effect of valence, $F(2,117)=757.18$, $p<.001$. Arousal scores were matched between positive ($M=5.95$, $SE=.17$) and negative ($M=6.31$, $SE=.14$) targets, $t(78)=-1.65$, $p=.10$. However, arousal scores differed between positive and neutral ($M=3.91$, $SE=.07$), $t(78)=11.14$, $p<.001$, and negative and neutral $t(78)=14.89$, $p<.001$, compatible with previous emotion studies (Kissler et al., 2009). Primes in the S+E+, S-E+ and S+, E- conditions differed for valence, similar to the targets (See table 1). Primes of positive and negative valence were matched for arousal and length in all conditions (See table 1). However, in the congruent condition neutral primes had higher frequency ratings than the positive and negative words. Similarly, positive primes had higher frequency ratings than negative and neutral primes in the incongruent semantic condition (see Figure 1 for valence and arousal scores of words included in the study). To elucidate whether frequency differences for the positive primes affected N400 and LPC responses to the targets, I ran some preliminary ERP analyses time-locked to the primes (see Section 2.8).

Table 1.

Pretest ratings for stimuli in each experimental condition. *indicates significance at the .05 level, SEs are reported in parentheses.

Condition	Valence	Arousal	Frequency	Length	Imagability
Targets					
Positive	7.77* (.08)	5.95 (.17)	46.93 (14.68)	7.05 (.31)	329.93 (37.73)
Negative	2.48* (.12)	6.31 (.14)	18.95 (2.99)	7.1 (.30)	274.5 (38.39)
Neutral	5.27* (.09)	3.91* (.07)	90.18 (40.56)	6.93 (.28)	308 (40.47)
Primes					
Congruent Condition- S+E+					
Positive	7.16* (.21)	5.14 (.21)	55.88 (17.56)	6.95 (.38)	217.65 (39.68)
Negative	2.71* (.13)	6.1 (.15)	22.93 (5.51)	6.15 (.33)	136.53 (.33)
Neutral	5.02* (.20)	3.91* (.17)	171.53* (.17)	5.63 (.29)	288.97* (.29)
Primes					
Incongruent Semantic- S-E+					
Positive	7.16* (.09)	4.87 (.15)	81.53* (24.37)	6.83 (.32)	378.83* (39.62)
Negative	2.87* (.13)	5.25 (.14)	12.73 (2.82)	6.18 (.31)	283.31 (39.49)
Neutral	5.32* (.07)	3.79* (.06)	49.08 (13.61)	6.45 (.35)	330.2 (42.83)
Primes					
Incongruent Emotion- S+ E-					
Positive	4.02* (.27)	5.07 (.23)	63.2 (16.36)	7.15 (.33)	281.56 (39.07)
Negative	6.15* (.17)	4.72 (.19)	106.78 (22.96)	7.38 (.38)	338.05 (37.42)
Neutral	5.04* (.30)	4.97 (.16)	71.13 (22.27)	7.8 (.34)	235.15 (42.22)

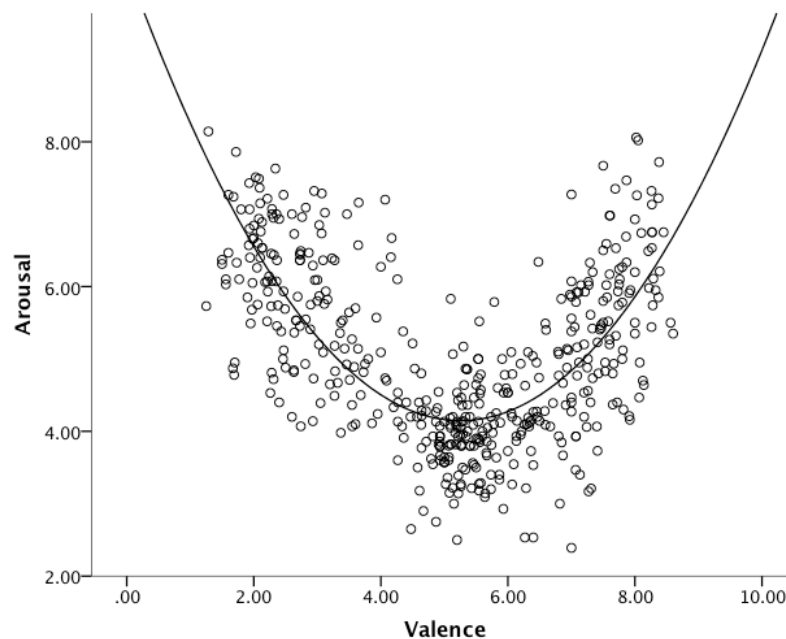


Figure 1. The relationship between valence and arousal for all words used in Chapter 5.

2.5 Semantic relatedness for stimuli used in ERP Chapter 5.

Prior to testing, participants who did not take part in the ERP study ($N=46$) rated the semantic relatedness of word-pairs (prime-targets) in the semantic and emotionally related condition (S+, E+), semantically unrelated (S-, E+) and emotionally unrelated but semantically related (S+, E-) conditions. Following the ERP study, 36 word-pairs were rated by participants who had taken part in the experiment ($N=38$). Participants were instructed to judge the semantic relatedness of the word-pairs (from 0 =unrelated to 5= very strongly related). All word-pairs with a score above 3 ('moderate-very strong semantic relationship') were classed as semantically related. Conversely, any word-pairs with a score below 1.5 were classed as semantically unrelated. The instructions informed participants, of the different types of semantic relationships with examples (thematic: 'dog and bone'; taxonomic: 'tennis ball & football'; synonyms: 'fear & frightened', and antonyms: 'good & bad'). The experimenter verbally re-iterated these relationships.

For the semantically related conditions (S+, E+ and S+E-), all word-pairs were moderately to strongly related (see Table 2). Positive ($M= 4.42$) and negatively ($M= 4.12$) valenced word-pairs were matched for the S+E+ condition, whereas neutral word-pairs had a significantly lower mean, but were still semantically related ($M=3.78$). All word-pairs were semantically related, in the S+ E- condition, and relatedness did not differ by valence (see Table 2). For the semantically unrelated condition (S-E+), word-pairs were all unrelated semantically but semantic relatedness differed by neutral valence. The neutral word-pairs were significantly less semantically related than both the positive and negative word-pairs.

Table 2.

*Mean scores for Semantic relatedness (S+, E+; S+, E-) and Incongruent Semantics (S+, E-) (SEs in parentheses). * indicates significance at the .05 level between positive, negative and neutral valence for each condition separately (S+E+; S+E-; S-E+).*

	S+E+ (e.g. GLORY-TRIUMPH) <i>M (SE)</i>	S+E- (e.g. DEFEAT-TRIUMPH) <i>M (SE)</i>	S-E+ (e.g. FAMILY-TRIUMPH) <i>M (SE)</i>
Positive	4.38(.08)	3.61(.15)	1.01(.11)
Negative	4.12 (.12)	3.55(.90)	1.04(.11)
Neutral	3.78 (.84) *	3.56 (.83)	.56 (.09)*

2.6 Pre-experimental ratings for word-lists.

Autobiographical memory study: Chapter 4.

Prior to conducting the study, a sample of 12-18 highly proficient Welsh-English bilinguals who did not participate in the autobiographical memory experiment, rated the valence and arousal of the two versions of the Welsh and English word lists. Age-range varied from 18-34 years of age, and a female majority (80%), to match the demographic of the autobiographical memory study. Participants were given a paper and pencil version of the SAM (Bradley & Lang, 1994; 1999) to rate the valence and emotional arousal (low of words included in the study (See Appendix B, for words). Participants were asked to circle a face depicting the emotional valence (1= sad face/ negative to 9=happy face/ positive) and a face depicting the level of emotional arousal (1=bored/ low arousal to 9= excited/ high arousal) they associated with the word. The Welsh and English language word lists were counterbalanced across participants, so some participants had the Welsh list first and vice versa. Prior to commencing the word list in the other language, participants had a break and

experimenter primed the participants in the other language, to minimize language interference (Grosjean, 1999).

Welsh and English word lists were matched for frequency, emotional intensity, valence and length, $F(1, 47) = 1.03, p = .32$; $F(1, 46) = .02, p = .90$; $F(1, 46) = .02, p = .90$; $F(1, 47) = .21, p = .65$, respectively. Affective valence differed between positive ($M = 7.68, SE = .21$) and negative ($M = 2.54, SE = .16$) words, $F(1, 46) = 375.61, p < .001$ but not between Welsh and English word-lists for positive, $F(1, 23) = .04, p = .84$ and negative words, $F(1, 23) = .14, p = .71$. The frequency norms were retrieved from the Brown corpus (Kucera & Francis, 1967) and Welsh language equivalent of the Brown database, the Cronfa Electronig Gymraeg (Ellis, O'Dochartaigh, Hicks, Morgan & Laporte, 2001).

Table 3.

Mean scores for Welsh and English versions of the autobiographical memory (SEs in parentheses).

	Welsh <i>M (SE)</i>	English <i>M (SE)</i>
Frequency	69.42 (14.80)	51.67 (9.36)
Arousal	6.27 (.22)	6.32 (.24)
Length	6.79 (.55)	6.46 (.47)
Valence	5.16 (.56)	5.06 (.58)

2.7 Experimental control for words used in the Welsh and English language IATs:

Chapter 3

To obtain valence and arousal ratings of the words included in the Welsh and English versions of the IAT, 12-20 participants were given two (Welsh and English) paper and pencil versions of the SAM (Bradley & Lang, 1994; 1999). The Welsh scale consisted of the Welsh attributes (e.g. da, drwg) used in the study whilst the English scale consisted of the English attributes (e.g. good, bad) used in the study (see Appendix C for the words). Welsh words were translation equivalents of the English words, and the attributes used in the IATs were identical to those used by Danzinger & Ward (2010). For each scale, words were organized in a random order and order of Welsh and English versions of the SAM were counterbalanced across participants. For both the Welsh and English IATs, words were matched on valence, $F(1, 19) = .35, p = .56$ and arousal, $F(1, 19) = .00, p = .99$. We also controlled for frequency and length between words used in the Welsh and English versions of the IAT, $F(1, 19) = .08, p = .78$ and $F(1, 19) = 1.55, p = .23$, respectively. Frequency ratings were obtained from the Brown corpus (Kucera & Francis, 1967) and the equivalent Welsh database—the Cronfa Electronig Gymraeg (Ellis, O’Dochartaigh, Hicks, Morgan & Laporte, 2001).

Table 4.

Mean scores for Welsh and English versions of the words included in the Welsh and English versions of the IAT (SEs in parentheses).

	Welsh <i>M (SE)</i>	English <i>M (SE)</i>
Frequency	181.40 (95.04)	147.20 (75.75)
Arousal	5.44 (.44)	5.43 (.38)
Length	4.00 (.33)	4.50 (.22)
Valence	5.28 (.94)	4.50 (.87)

2.8 Preliminary analyses on the primes: Chapter 5.

In Chapter 5, we reported that there was an attenuated N400 effect for the high AD group but a typical N400 semantic congruency effect for the low AD group for positively valenced congruent compared to incongruent semantics. We analysed ERPs time-locked to the targets- such that the primes would provide contextual constraints on the following target. However, since primes were not matched for frequency for the positively valenced primes, it could be possible that baseline differences with the primes were driving the different ERP effects. We therefore ran some preliminary analyses on ERPs time-locked to the primes to elucidate whether baseline differences in valence of the primes could be affecting the N400 differences to the targets.

For the early time-window (350-500 ms, see Chapter 5 for more details) we ran separate 3 (positive, negative, neutral) x ES x group (low vs. high AD) repeated measures ANOVAs for anterior and posterior electrode sites separately (see Chapter 5 for electrode site selection). We also ran repeated measures ANOVAs on ERPs to valenced primes in the

later time-window (610-810 ms, see chapter 4 for further details) using anterior and posterior electrode sites.

Early time-window (350-500ms).

For both anterior and posterior electrode sites there was a main effect of valence, $F(1.82, 52.67) = 6.98, p < .01, \eta^2 = .19$ and $F(1.94, 56.33) = 4.30, p = .02, \eta^2 = .13$, respectively. Neutral primes elicited a greater negativity- N400 ($M = -1.02, SE = .70$) than positive ($M = .30, SE = .47$) and negative ($M = .40, SE = .58$) primes (see Figure 2), for both anterior and posterior sites. Near significant interactions were found between valence x group for anterior, $F(1.82, 52.66) = 3.09, p = .06, \eta^2 = .10$ and posterior sites, $F(1.94, 56.33) = 2.52, p = .09, \eta^2 = .08$. The interactions will be explored further under group effects, below.

Late time-window (570-770 ms).

There was a main effect of valence for both anterior, $F(1.86, 53,10) = 7.67, p < .01, \eta^2 = .21$ and posterior sites, $F(1.77, 51.22) = 8.97, p < .01, \eta^2 = .24$. For both anterior and posterior sites, positive ($M = .93, SE = .62$) and negatively valenced ($M = 1.36, SE = .68$) primes had a more positive amplitude (LPC) than neutral primes ($M = .20, SE = .66$) (see Figure 2). However, there were significant valence x group interactions for anterior, $F(1.86, 53.10) = 4.67, p = .01, \eta^2 = .14$ and posterior sites, $F(1.77, 51.22) = 3.41, p = .05, \eta^2 = .11$. The interactions will be explored further under group effects, below.

Group Effects

We explored the near significant and significant interactions found between valence and group – in the early and late time-windows - by running separate repeated measures

ANOVAs, 3 (valence) x ES, for each group. We ran analyses for anterior and posterior sites separately. We also used paired t-tests to further explore valence effects.

Low AD

Early time window (350-500 ms)

For the low AD group, valenced primes elicited similar amplitudes of the N400 for positive, negative and neutral valence. There was no main effect of valence for either the anterior $F(1.20, 31.95) = .91, p = .41, \eta^2 = .05$ nor posterior $F(1.87, 30.17) = .23, p = .78, \eta^2 = .01$ electrode sites (See Figure 2).

Late time window (570-770 ms)

Similarly, there was no main effect of valence for anterior sites in the late time-window, $F(1.62, 2.36) = .98, p = .37, \eta^2 = .06$. For posterior sites, a near significant main effect of valence was elicited for ERPs to valenced primes in the late time-window, $F(1.74, 27.77) = 2.88, p = .08, \eta^2 = .15$. To elucidate whether ERP amplitudes differed by valence for the low AD group, we ran paired t-tests between valenced primes. Negatively ($M = 1.57, SE = .77$) valenced primes elicited a greater positivity- LPC than both positive ($M = .78, SE = .66$) and neutral primes ($M = .82, SE = .59$); $t(16) = -1.92, p = .07, t(16) = 1.88, p = .08$, respectively. However, these differences failed to reach statistical significance (see Figure 2).

High AD

Early window (350-500 ms)

For the high AD group, there was a main effect of valence for both the anterior and posterior sites, $F(1.51, 19.61) = 6.70, p = .01, \eta^2 = .34$ and $F(1.97, 25.57) = 4.38, p = .02, \eta^2 = .25$, respectively. Paired t-tests revealed that neutral primes ($M = -2.75, SE = 1.80$) elicited a greater negativity (N400) than positive ($M = -.69, SE = 1.21$) and negative primes ($M = -.82,$

$SE = 1.40$), $t(13) = 2.68$, $p = .02$ and $t(13) = 3.06$, $p = .01$; posterior, $t(13) = 2.65$, $p = .02$, $t(13) = 2.55$, $p = .02$ (See Figure 2).

Late window (610-810 ms)

Similarly to the early time-window, there was a main effect of valence for both anterior, $F(1.90, 24.65) = 9.0$, $p < .01$, $\eta^2 = .41$ and posterior sites $F(1.49, 19.39) = 7.69$, $p = .01$, $\eta^2 = .37$ (See Figure 2). Paired t-tests reveal that both positive ($M = 1.40$, $SE = 1.09$) and negatively ($M = 1.72$, $SE = 1.16$) valenced primes elicited a greater positivity -LPC - than neutral primes ($M = -.19$, $SE = 1.12$) for anterior, $t(13) = 3.58$, $p < .01$, $t(13) = 3.57$, $p < .01$ and posterior sites, $t(13) = 3.14$, $p = .01$ and $t(13) = 2.96$, $p = .01$.

Summary & conclusions for ERPs to primes

For both the early and late time-windows there were main effects of valence. In the early window, neutral primes elicited a larger N400 compared to positive and negatively valenced primes. Conversely, in the late time window both positive and negative primes elicited a greater positivity than neutral primes. However, in both time windows there were interactions between group and valence, indicating that the groups were processing valence differently. For the low AD group, valenced primes elicited similar amplitudes for the N400 in the early window, and similar amplitude of the LPC in the later window. Although, ERPs to valenced primes differed at anterior and posterior sites, these effects failed to reach significance. The high AD group elicited a greater N400 for neutral compared to positive and negative primes, in the early window. A larger LPC was elicited for positive and negative compared to neutral primes in the late window- but only for the high AD group. ERPs to primes at anterior and posterior sites did not differ for the high AD group.

When groups are combined, similar ERP responses are elicited in the early and late windows, but these ERP effects interact with group and valence. Similar to Chapter 5, we

report that only the high AD group elicits different ERP responses to valenced primes. In Chapter 5, the high AD group had semantic congruency effects (N400) for negative and neutral word-pairs, but an LPC effect for positive related semantic compared to unrelated semantic word-pairs. A possible reason for the different ERP responses for positive valence in Chapter 5 could have been poor experimental control on a parameter such as frequency. Positive primes in the semantic incongruent condition had a higher frequency than both negative and neutral primes (see Table 1). However, higher frequency typically elicits a smaller N400 response (Rugg, 1990), but N400 congruency effects for the low AD group did not differ as a function of valence for the targets examined in Chapter 5, nor for the primes in this analysis. Thus, poor control over frequency for positive primes is not consistent with an augmented N400 response to positive word-pairs in Chapter 5, and comparable magnitude of N400 for each valence of the primes.

Similarly, for the high AD group, ERPs to positive and negative primes elicit LPC responses of similar magnitudes, suggesting baseline differences with frequency cannot be responsible for the LPC to positive semantic related vs. unrelated word-pairs in Chapter 5. However, the N400 for negative unrelated compared to related word-pairs was larger than for the positive word-pairs, which elicited an LPC. We will discuss further implications and interpretations about the primes in the general discussion section.

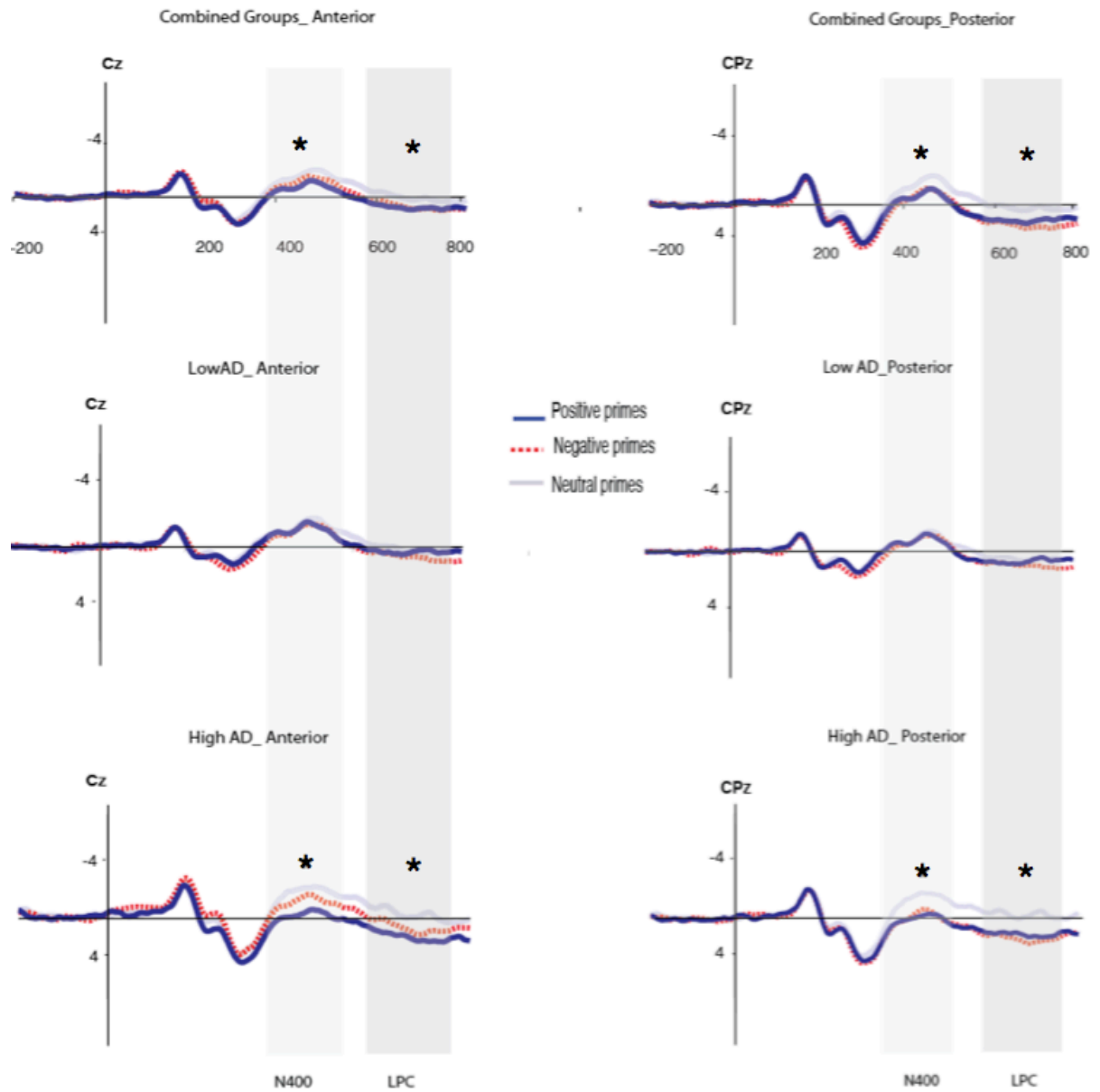


Figure 2. ERPs to valenced primes in the early and late time windows. * indicates significance at .05 level.

CHAPTER 3

Age and order of language acquisition in early bilinguals predicts strength of implicit and explicit cultural biases differentially¹.

3.1 Abstract

Implicit and explicit cultural biases have been associated with differential developmental trajectories in monolinguals. Recent research shows language context can influence implicit cultural biases in bilingual adults. However, little is known about how bilinguals develop and maintain these biases. This is the first study to examine how the age and order of language acquisition affect implicit and explicit cultural biases. Implicit and explicit biases were modulated differentially by order of acquisition of first (L1) and second (L2) language in early Welsh/English bilinguals. The effect of L1 Welsh had the strongest effect on implicit cultural biases, but explicitly this bias was reduced. In contrast, the opposite effect was apparent for the L2 Welsh bilinguals who had the greatest explicit Welsh bias but lowest implicit Welsh bias. The findings show that language acquisition serves as a specific form of childhood experience that is highly correlated with the cultural associations of adults.

¹ This paper is currently undergoing revisions for re-submission to Psychological Science

3.2 Introduction

Previous studies have examined implicit and explicit race biases throughout the course of development from childhood to adulthood (Baron and Banaji, 2006; Dunham, Baron and Banaji, 2008). Baron & Banaji (2006) suggested that children display adult-like implicit attitudes from the age of six years onwards. Recently, however, Dunham, Chen and Banaji (2013) reported that adult-like implicit biases are apparent in children aged three. Typically, the implicit bias is more positive for the majority group, regardless of whether those tested are from the minority group. Explicit biases appear to have a more protracted course of development, influenced by social desirability effects and motivation (See Frith & Frith, 2008 for a review). The language background of participants recruited to studies of race/cultural biases is typically not reported and very little is known about the interaction between cultural development and language acquisition. The present study is the first to examine age of acquisition effects on cultural identity in two groups of nonimmigrant early bilinguals matched on age of L2 acquisition, and from the same ethnic and socio-economic backgrounds.

Over 50% of the world's population is bilingual (French & Jacquet, 2004). A plethora of studies have reported that the age at which a bilingual learns their second language can have marked effects on grammatical proficiency (Johnson & Newport, 1989), degree of foreign accent (Flege, et al., 2006) and brain organization (Perani et al., 1998). Although not as widely researched, the non-linguistic functions such as emotional processing and decision-making are differentially implicated in each language of a bilingual. The role that the two languages serve may be markedly different depending on age of acquisition and language usage (Dewaele, 2010). The first language is associated with greater level of emotionality (Aragno & Schlachet, 1996; Harris, 2003) and can be a cultural identity marker (Williams, 2009). The second language has recently been associated with better decision-

making performance as a consequence of reduced emotionality (Keysar, Hayckawa & An, 2012). While studies on racial identity development are in abundance there is a dearth of literature addressing the role of language acquisition and its effects on cultural identity and cultural understanding.

It is clear that cultural identity begins to develop at an early age, well before adulthood. Social identity development theory (Nesdale, 2004) asserts that children are able to identify their own in-group by 4 years of age. Bigler, Jones and Lobliner (1997) reported that children, aged 7-9, who were assigned to either a blue or yellow group, rated their in-group members more favourably. By age 10, this explicit in-group bias is reduced unless ethnic prejudice is present (Durkin, Nesdale, Dempsey and MacLean, 2012), which is especially likely when in-group members identify strongly with their culture and are victimized by a majority out-group. For example, Hendry, Mayer and Kloep, (2007) examined the explicit cultural identity of children between the ages of 9-17 in Wales; they conducted several interviews and asked participants to write essays about their heritage. They found that children as young as 9 displayed a sense of belonging to Wales, and a defensive aggression to the majority British culture.

Within the context of early cultural identity development, it is important to consider other developmental influences, and in particular, language acquisition and its links to culture. Recent evidence shows that language context primes cultural associations: bilinguals show an implicit bias towards the culture consistent with the language context, as seen in bilingual Arab-Israelis (Danziger & Ward, 2010), Arabic-French Moroccans and Hispanic Americans (Ogunnaike, Dunham & Banaji, 2010). Such results show that, regardless of what a person might explicitly report, cultural bias reflects dynamic and context-sensitive cognition. But further, these same results raise the question, is early language acquisition associated with a long-lasting cultural bias?

The bilingual population in North Wales provides a unique opportunity to test this question. Although English is the majority language in most of Wales, some areas have high concentrations of first language Welsh/English bilinguals. Census data has shown that parts of Gwynedd County, e.g. Caernarfon, and Anglesey have a high-density of Welsh speakers (85.6%, ~65% and ~74% respectively: Office for National Statistics, 2001; 2011), and virtually all fluent Welsh speakers will be bilingual in English (Gathercole, 2007). If we consider school-age children in Gwynedd, for example, over 90% of children age 5-9 in this area are Welsh speaking (Welsh Language Commissioner, based on 2011 census) and official education policy within primary schools is to develop full Welsh/English bilingualism by the age of 11. An important feature of the North Wales testing environment is therefore the availability of nonimmigrant bilingual adults, fluent in both Welsh and English, who received substantial exposure to L2 at an early age.

We examined the implicit and explicit cultural biases of Welsh-English early bilinguals, matched on age of acquisition for L1 (from birth) and L2: That is, L1 Welsh-speakers who began learning L2 English early, i.e., from 5-8 years, and L1 English-speakers who began learning L2 Welsh at a matched early age. If early processes relating to implicit cultural bias are correlated with language development, then we might expect a relative bias towards the L1 over the L2 culture, even in adulthood, and even with early exposure to L2. We also assessed whether implicit cultural bias was correlated with explicit reported cultural identity.

3.2.1 Method

Participants

One hundred and twenty eight Welsh-English bilingual speakers completed online questionnaires, relating to language background and cultural identity. Forty-five participants were selected from those who had agreed to be approached about follow-up studies. The age

range varied from 18-35 and gender was balanced across groups, with a female majority (N = 32). Ninety one per cent (N=41) of participants reported being Welsh whilst the remaining 9% identified themselves as British. This reflected the larger sample in which 89% (N=114) of participants reported being Welsh.

All participants were early bilinguals matched for age of acquisition for first and second language (4-8 years), based on a language background questionnaire (Thomas and Gathercole, 2007). Participants were allocated into three groups of 15, based on order of acquisition of Welsh and English, resulting in L1 Welsh and L1 English groups. A simultaneous group of bilinguals who learned both Welsh and English from birth served as a control group. However, to control for cultural identity, only the participants who identified as Welsh were entered into subsequent analyses. The sample size for the L1 Welsh group remained unchanged (N=15), but the simultaneous and L1 English group consisted of 14 and 12 participants, respectively. All participants were highly proficient bilinguals, determined by their scores on proficiency measures.

Measures

Language Background. The Language Background Questionnaire (LBQ, Thomas & Gathercole, 2007) is a self-report measure of language proficiency. Questions, presented in both Welsh and English, determine age of acquisition for each language, everyday language usage and perceived language ability. Based on age of acquisition reported in the LBQ, participants were separated into appropriate groups (L1 Welsh, simultaneous, and L2 Welsh) according to ages described above.

Language proficiency. English fluency was assessed using the British Picture Vocabulary Scale (BPVS; Dunn, Dunn and Whetton, 1982). The BPVS is a standardized assessment of receptive vocabulary typically used to assess children's reading ability. Four pictures are displayed on each page of the test booklet, with one picture corresponding to a

target word. A number of studies have used this as a measure of language proficiency in bilingual adults (Majerus, Poncelet, Van der Linden, & Weekes, 2008). Welsh fluency was assessed using the equivalent *Prawf Geirfa Cymraeg i Oedolion* (PG; Gathercole & Thomas, 2007). The PG is structured so that a target word corresponds directly to one picture out of a set of four, displayed on a computer screen. As the PG is in the process of being validated, no standardized norms are available. However, the words used in the test become increasingly harder (lower frequency) as the test progresses.

Explicit cultural identity: Multi-group ethnic identity measure (MEIMS; Phinney, 1992). The MEIMS was used to assess explicit cultural identity, and was presented bilingually. Participants initially report their cultural group (e.g. Welsh, English, Irish, British, etc), with all remaining questions relating to that group. The questionnaire consists of two subscales (Phinney, 1992; Roberts et al., 1999) ‘Identity Search’ and ‘Sense of Belonging, Affiliation and Commitment’. High scores on the identity search indicate active engagement in learning more about the culture. A high score on the affiliation and belonging subscale indicates greater cultural pride.

Implicit cultural bias: Implicit Association Test (IAT, Greenwald, McGhee, & Schwartz, 1998). The IAT has been used to determine people’s attitudes to racism (Castelli et al., 2009), political stances (Plant et al., 2009), and cultural attitudes (Danziger and Ward, 2010). The current study adapted the IAT to test the implicit attitudes of our participants with regard to Welsh vs. English cultural identity. Both Welsh and English versions of the IAT were administered, on separate sessions. The concepts chosen were Welsh (Ieuan, Dafydd, Rhys, Branwen, Cerys) vs. English names (Henry, John, David, Alice, Mary). These concepts (Welsh and English names) remained identical for the English language IAT. The attributes selected were consistent with those used by Danziger and Ward (2010) and consisted of pleasant (good, smart, clean, happy, strong) vs. unpleasant words (bad, dumb,

dirty, weak, angry) or equivalent pleasant (da, clyfar, glân, hapus, cryf) and unpleasant (drwg, twp, budr, gwan, blin) attributes in the case of the Welsh version. In the first two blocks, participants sort concepts and attributes separately, using either a left ('d') or right button press ('k') to assign the stimuli to categories. In subsequent blocks participants have to sort combined lists of concepts (Welsh vs. English names) and pleasant and unpleasant attributes. To assess implicit attitudes, response times when sorting the combined block 'Welsh and good' vs. 'English and bad' are compared to those in another combined block where keyboard presses are reversed for attributes ('Welsh and bad' vs. 'English and good'). The relative strength of association was computed as a D-score using the revised algorithm by Greenwald, Banaji and Nosek (2003).

Procedure

The Language Background Questionnaire and the MEIMS were both presented online, with all questions presented in both languages. Participants attended two separate testing sessions, of which one was conducted in Welsh and the other in English, by the experimenter (LH) who was fully bilingual. Within the Welsh session, the PG and Welsh IAT were conducted through the medium of Welsh. The remaining assessments in the English session were conducted in English. The order of the sessions was counterbalanced to minimize any experimental confounds.

3.2.2 Results

Proficiency tests (BPVS and PG)

Groups did not differ for their English proficiency, $F(2, 38)=1.57, p=.22, \eta^2 = .08$ (See Table 1, for means and S.Es). However, Welsh proficiency differed between the groups,

$F(2,38)= 14.27, p < .001, \eta^2 = .43$. LSD post hoc analyses revealed the L1 Welsh group has a significantly higher proficiency score than both the simultaneous and L2 Welsh bilinguals.

Table 1.

Mean scores for English proficiency (BPVS) and Welsh proficiency (PG) for all groups (SEs in parentheses).

	<i>n</i>	<i>BPVS</i> <i>M (SE)</i>	<i>PG</i> <i>M (SE)</i>
L1 Welsh	15	136.74 (1.54)	94.13 (1.37)
Simultaneous	14	140.21 (1.60)	87.57 (1.42)
L2 Welsh	12	140.08 (1.72)	83.33 (1.54)

3.2.3 Explicit Cultural Identity

For the explicit identity measure (MEIMS), the ‘Identity Search’ subscale had a significant main effect of group, $F(2,38)= 4.50, p=.02, \eta^2 = .20$, and the ‘Affiliation and Belonging’ subscale had a near significant main effect of group, $F(2,38)= 2.72, p=.08, \eta^2 = .12$. In the larger sample ($N=114$), both ‘Identity Search’ and ‘Affiliation and Belonging’ subscales yield a significant main effect of group, $F(2,111)= 10.73, p < .001, \eta^2 = .16$ and $F(2,111)= 6.20, p=.003, \eta^2 = .10$, respectively. On both subscales (for both samples), L1 Welsh participants had lower explicit identity scores than both the simultaneous and L2 Welsh participants (See Figure 1). LSD post-hoc analyses revealed a graded effect of group, with lower scores for the L1 Welsh increasing for simultaneous to the highest score for L2 Welsh. Possible scores on the MEIMS range from zero to four. Lower scores here indicate less engagement and cultural pride than the higher scores (see Figure 1).

To determine whether Welsh proficiency scores could affect explicit identity scores,

scores on the Prawf Geirfa were correlated with both subscales of the explicit identity scores. Both the Identity search, $r(39) = -.40, p = .01$, and the combined scores $r(39) = -.34, p = .03$, yielded significant negative correlations with Welsh language proficiency scores, indicating that the lower the Welsh proficiency score, the higher the cultural identity score. For the Affiliation and belonging subscale proficiency and explicit identity was not significant, $r(38) = -.22, p = .17$.

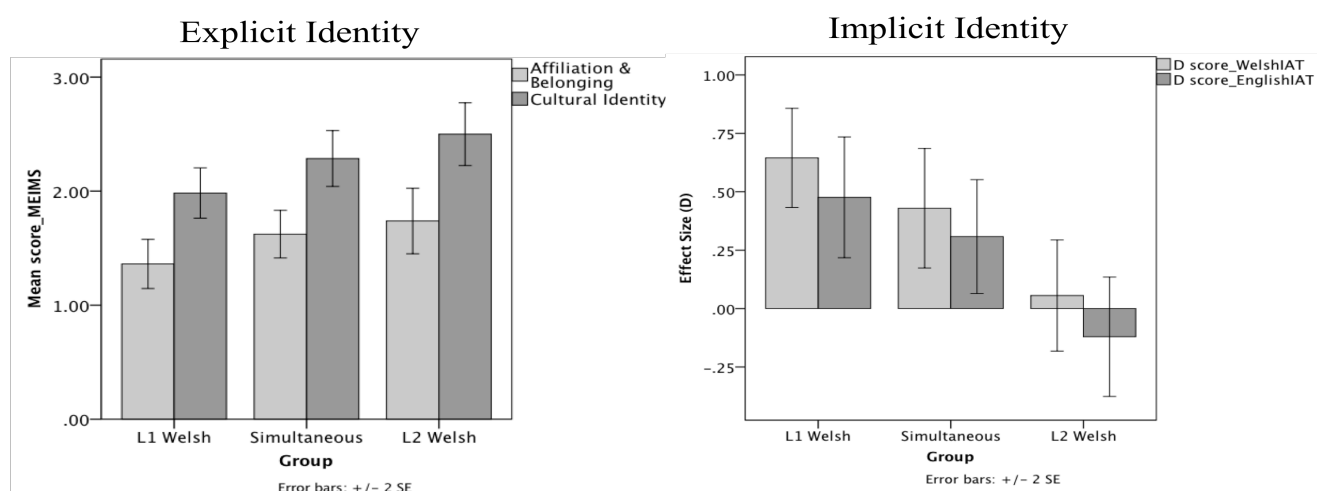


Figure 1. Explicit and implicit cultural biases are depicted in this figure. Order of Welsh and English language acquisition has a differential effect on implicit and explicit cultural identity. There is a graded effect between the groups, with the L1 Welsh bilinguals having the greatest implicit Welsh bias (highest D-score). Intriguingly, the opposite pattern is visible for the explicit identity, with the L2 Welsh bilinguals showing the highest Welsh bias.

3.2.4 Implicit Cultural bias

Scores on both versions of the Welsh and English versions of the IAT are shown in Figure 1. A higher D-score indicates a more positive implicit attitude towards the Welsh culture. To assess the effects of language acquisition and language context on implicit cultural bias, we ran a repeated measures ANOVA (language x group). Comparisons between the Welsh and English language IATs revealed that language of presentation

modulated the implicit Welsh bias (strength of the D-score), $F(1,38)=5.30, p=.03, \eta^2 = .12$, with all groups showing a reduced Welsh bias during the English language presentation. The groups nonetheless varied on strength of implicit bias, $F(2,38)=7.54, p<.001, \eta^2 = .40$. LSD post-hoc comparisons confirmed that the L1 Welsh ($M=.56, SE=.10$) and simultaneous bilinguals ($M=.37, SE=.11$) had a significantly greater Welsh bias (higher D-score) than the L2 Welsh group ($M=-.03, SE=.12$) for both Welsh and English IATs. There was no significant interaction between language and group, $F(2,38)=.06, p=.94, \eta^2 <.01$.

To test whether Welsh IAT effects were driven by differences in proficiency (reported above), Welsh proficiency was added as a covariate. Effects were similar to the English language IAT, with a main effect of group, $F(2, 38)= 3.76, p=.03, \eta^2 = .17$. Both L1 Welsh ($M=.65, SE=.14$) and simultaneous bilinguals ($M=.43, SE=.12$) had higher D-scores than the L2 Welsh ($M=.06, SE=.15$). As with the English language IAT, a graded effect is apparent with D-scores decreasing from L1 to L2 Welsh bilinguals.

3.3 Discussion

This study is the first to examine the interaction between cultural identity and order of language acquisition. The results demonstrate surprisingly close links between language development and cultural cognition in Welsh/English bilinguals. We found that even early differences in age and order of acquisition were correlated with a graded effect on implicit cultural bias. For both Welsh and English versions of the IAT, the L1 Welsh bilinguals had the strongest Welsh bias, followed by the simultaneous and L2 Welsh bilinguals. Interestingly, the implicit measure of cultural bias was dissociated from explicit reports of cultural identity. The L2 Welsh bilinguals displayed the greatest explicit Welsh bias, followed by the simultaneous and L1 Welsh bilinguals. We consider these findings in turn.

First, our results extend current accounts of how children acquire intergroup

associations. Dunham et al (2013; see also Baron & Banaji, 2006; Dunham et al, 2008) argue that unlike explicit group biases, children show implicit racial biases, which are indistinguishable from that of adults (Baron & Banaji, 2006; Dunham et al, 2008, 2013). The present study extends this account by identifying a specific form of childhood cultural experience -- the context of language acquisition -- which differs between our participants, and which is then highly correlated with their cultural associations as adults.

A particular value of the present study is the control available over the L2 groups, and it is important to appreciate the language environment of the study. Conventionally, age of acquisition studies compare groups of bilinguals who learned their L2 at different ages (e.g. comparing L2 proficiency for early versus late learners of L2; Perani et al., 1998; Newport & Johnson, 1989). This approach makes it difficult to disentangle experiential from maturational effects. It is therefore important that the L2/Welsh and L2/ English groups were matched here for age of L2 acquisition. Furthermore, the age of L2 exposure is relatively early (from 5 to 8 years). Additionally, because the participants were drawn from the same geographical area, they had similar economic backgrounds, and ethnicity. Therefore it seems likely that the effects of language on cultural cognition, are tied to order of acquisition, i.e. experience, rather than between-group differences in brain maturation.

Second, we found effects of language on explicit biases that were dissociated from the implicit biases. The L2 Welsh group did not show an implicit bias towards Welsh, but reported an explicit bias towards Wales greater than the L1 Welsh or simultaneous groups. At present, we suggest these results are compatible with social hierarchy effects driving socially desirable responding. Social desirability may stem from the desire to be part of the in-group (Brewer, 2001) and to resolve cognitive dissonance at being a member of the minority group (Festinger & Carlsmith, 1959). In particular, the explicit reports of favourable Welsh identity across groups are consistent with a strong norm in this region of

Wales reflecting pride of Welsh culture and the Welsh language. This is reminiscent of results with racial bias, in which explicit reports are consistent with egalitarian ideals even in the presence of implicit bias against a minority group (e.g. Dunham et al, 2008).

In conclusion, our findings on bilingual language acquisition fit within an emerging picture of how racial, ethnic, and cultural biases develop from childhood to adulthood. Age and order of language acquisition reflect childhood experience, which is correlated with a graded effect on the implicit cultural biases of adults. Although our study, like others in this area was not longitudinal, the consistency of racial bias in cross-sectional developmental studies (Dunham et al., 2013; Baron & Banaji, 2006) indicates implicit biases established early in childhood could be stable over time. Potentially then, the language context of early childhood may promote a variety of within- and between-group associations, lasting into adulthood. Equally important to note however is that the explicit reports of cultural values appear to be less closely tied to these early experiences, and perhaps, more open to effects of education and reflection. It is important to note that these results pertain to nonimmigrant bilinguals in which Welsh is a minority language in the UK, but a majority language locally. Age of language acquisition effects on cultural identity may be even more pronounced or completely different for bilinguals trying to integrate into a foreign country.

CHAPTER 4

Valence and proficiency modulate autobiographical memory structure in second language early Welsh-English bilinguals.

4.1 Abstract

Autobiographical memory studies with bilinguals and psychiatric populations indicate that language and emotion modulate autobiographical memory retrieval. Emotional arousal is associated with facilitated autobiographical memory recall, but can differ between a bilingual's languages. We examined autobiographical memory retrieval in early Welsh-English bilinguals. Specifically, we examined whether the structure of autobiographical memories differed between the first (L1) and second languages (L2), based on the self-memory theory system (Conway & Pleydell-Pearce, 2000). Welsh-English bilinguals retrieved memories associated with positive and negatively valenced cue words. We categorized memories according to memory type (specific-general-timeline), based on a model of hierarchical memory structure. The proportion of memory types retrieved was comparable for L1 and L2 across groups. However, for second language Welsh bilinguals, valence modulated the memory type retrieved in their L2. The L2 Welsh bilinguals had a larger discrepancy in proficiency between their first and second languages, suggesting that proficiency differences can modulate the structure of autobiographical memories. Remarkably, the level of emotional arousal was similar between L1 and L2, regardless of proficiency and age of acquisition. Our results were the first to measure the structure of autobiographical memory retrieval whilst controlling for age of language acquisition in bilinguals. Additionally, our finding that proficiency does not modulate emotional arousal can account for discrepancies in bilingual emotion literature.

4.2 Introduction

Autobiographical memories are memories associated with past experience and personal events (Conway & Pleydell-Pearce, 2000; Williams, Healy & Ellis, 1999; Belli, 1998; Conway & Rubin, 1993). According to Conway & Pleydell-Pearce's (2000) self-memory system theory, an individual's autobiographical knowledge is organized hierarchically, according to degree of specificity, from the most abstract to the most specific memories. For example, 'lifetime' autobiographical memories represent the most abstract knowledge structure, associated with a particular period of life (e.g. University). General memories are the second level of autobiographical knowledge and refer to repeated events nestled within the aforementioned 'lifetime' periods (e.g. attending a particular class in University); that are more specific than lifetime knowledge. Finally, event specific memories relate to autobiographical knowledge that is highly specific with vivid details, and are typically temporally constrained, lasting no more than several hours (e.g. going for lunch with a friend in a café). Support for a hierarchical memory structure comes from behavioural studies involving monolinguals (Belli, 1998; Conway & Rubin, 1993; Williams, Healy & Ellis, 1999), psychiatric patients (Gibbs & Rude, 2004; Williams & Dritschel, 1992; Kaney, Bowen-Jones & Bentall, 1999; Wilhelm, McNally, Baer & Florin, 1997) and neuroimaging experiments (Addis, McIntosh, Moscovitch, Crawley & McAndrews, 2004), examining how participants retrieve autobiographical memories, based on preceding cue words.

For example, an fMRI study conducted by Addis et al., (2004) examined the time-course and extent of neural activation between retrieving general versus specific autobiographical memories. The authors report more distributed neural activity and increased latency in retrieving specific versus general autobiographical memories, which could indicate longer processing is necessary to generate specific compared to general memories. However, distributed neural activity is also related to more effortful processing (Sarter,

Gehring & Kozak, 2006) and does not necessarily indicate a hierarchical memory structure. Nevertheless, some support that general and specific autobiographical memories are processed differently comes from research with psychiatric patients (Williams & Broadbent, 1986; Kaney, Bowen-Jones & Bentall, 1999), who elicit a preponderance of general rather than specific memories (Kuyken & Dalgleish, 1995; Kleim & Ehlers, 2008). Similarly, bilinguals' autobiographical memories have been tied to lifetime periods, specifically the language used during memory encoding (Marian & Neisser, 2000; Larsen, Schrauf, Fromholt & Rubin, 2002). However, no study has explicitly examined the structure of a bilingual's autobiographical memory in each respective language. Studies with psychiatric patients and bilinguals can help elucidate the effect of emotion on autobiographical memory structure and retrieval.

4.2.1 Autobiographical memory in psychiatric patients

Studies examining autobiographical memory in patients suffering from depression have not only provided support that more general than specific memories are retrieved when compared to controls (e.g. Williams & Broadbent, 1986; Kaney, Bowen-Jones & Bentall, 1999), but have also demonstrated how low positive affect and blunted emotion can effect memory retrieval. A seminal study by Williams and Broadbent (1986) developed the autobiographical memory test (AMT), which asks participants to generate specific memories relating to a number of positive (e.g. 'happy') and negative (e.g. 'sad') cue words. This was the first in a number of studies (e.g. Williams & Dritschel, 1992; Kuyken & Dalgleish, 1995; Kleim & Ehlers, 2008) to report that people with suicidal ideation/ depression responded to cue words with over-general memories, rather than the more specific memories retrieved by controls. Studies examining autobiographical memory in other psychiatric disorders such as post-traumatic stress disorder, obsessive-compulsive disorder, psychosis and bipolar have also reported an over-general memory retrieval style (McNally, 1998; Wilhelm, McNally,

Baer & Florin, 1997; Kaney, Bowen-Jones & Bentall, 1999; Mansell & Lam, 2004).

Although clinical presentation for each of these disorders is markedly different, the core similarity is difficulty with emotional processing (perhaps due to co-morbidity with depression). This could explain why retrieving general rather than specific autobiographical memories are common across these disorders.

Although autobiographical memory models (Conway & Pleydell-Pearce, 2000) do not encompass an emotional element in the model per se, based on the above findings and recent literature reviews, emotion has been linked to autobiographical memory retrieval (see reviews by Buchanan, 2007; Holland & Kensinger, 2010). Further evidence for involvement of emotion in autobiographical memory comes from establishing that similar neural networks (hippocampal formation, amygdala and orbito-frontal cortex) are involved in both memory and emotional processes (Kensinger, 2009; Cabeza & St Jacques, 2007). Emotional intensity or arousal (we will use these terms interchangeably) has been reported to be a better predictor of specific memory generation than valence (e.g. Talarico, LaBar & Rubin, 2004). Findings for memory recall and valence typically report enhanced recall for negative compared to positive memories (e.g. Bernsten, 2002; Kensinger & Corkin, 2003). However, enhanced recall has also been found for positive valence (e.g. Ferre et al., 2010) or no memory enhancement differences between positive and negative valence (Talarico et al., 2004). Similar mixed findings for the effects of valence and arousal on memory have been reported for bilingual memory recall (Aycicegi-Dinn & Caldwell-Harris, 2004, 2009) and bilingual autobiographical memory (Marian & Kaushanskaya, 2004, 2008). However, these studies have not controlled for age of acquiring first and second languages, which could modulate emotional processes (e.g. Anoshian & Hertel, 1994).

4.2.2 Bilingual memory & emotion

Bilingual autobiographical memory and recall studies (Aycicegi-Dinn & Caldwell-Harris, 2004, 2009; Marian & Kaushanskaya, 2004, 2008) have indicated that emotion is processed differentially in the first (L1) and second (L2) language. Findings from these studies are mixed, with some studies reporting an emotional recall bias for positive and negative words in the first language (e.g. Anooshian & Hertel, 1994); other studies suggesting either no emotional bias between languages for positive and negative words (e.g. Ferre et al., 2010; 2013; Aycicegi-Dinn & Caldwell-Harris, 2009) or greater emotional recall for taboo and positive words in the second language (Ayciegi-Dinn & Caldwell-Harris, 2004). Mixed findings could be related to the level of control employed for the emotional arousal of stimuli between studies; only Ferre et al., (2010) explicitly controlled for emotional arousal.

Other variables differing between these studies were age of acquisition of first versus second language, and degree of language proficiency. In processing models such as Kroll & Stewart (1994), proficiency and age of acquisition are implicated as factors that influence the lexical representation of words in L1 and L2. The authors suggest there are two lexicons for bilinguals, which are mediated by an overarching conceptual representation. Lexical representations associated with the first language (L1) are accessed to produce meaning in the second, less proficient language (L2). However, this model does not include an affective element, and therefore cannot explain divergent emotional memory findings in bilinguals. Intriguingly some studies have found no differences in emotional memory between L1 and L2, irrespective of control for age of acquisition and proficiency (e.g. Eilola, Havelka, & Sharma, 2007). Using an emotional Stroop test, Finnish-English bilinguals, who learned English after age 12, demonstrated the same level of emotional activation and negative bias in both languages, regardless of age of acquisition (Eilola, et al., 2007). Ferre et al. (2010)

controlled for proficiency with two groups of early bilinguals who were dominant in either Spanish or Catalan, and determined that language dominance did not yield different results for positive and negative words compared to neutral words for either language. In addition, later age of acquisition and lower proficiency did not modulate strength of emotional recall effects for a group of Spanish-English bilinguals, who learned English at the mean age of 8.6 years.

Typically mixed findings for emotional memory differences between L1 and L2 have been elicited using memory recall (Aycicegi-Dinn & Caldwell-Harris, 2004, 2009), emotional stroop (Eilola et al., 2007) and skin conductance response tasks (Ayciegi-Dinn & Caldwell-Harris, 2004). However, these tasks do not include the retrieval of spontaneous emotional memories associated with autobiographical knowledge. A bilinguals' autobiographical memory retrieval enables researchers to examine the emotional lexicon of bilingual participants through the narratives elicited (Marian & Neisser, 2000; Larsen, et al., 2002; Marian & Kaushanskya, 2004). Emotional narratives (or autobiographical memories) elicited using valenced cue words enable researchers to determine the emotional arousal expressed in each respective language (Marian & Kaushanskya, 2004; Fivush & Nelson, 2004).

4.2.3 Bilingual autobiographical memory

Autobiographical memory studies suggest that for bilinguals, language and culture are important factors in autobiographical knowledge structures (Marian & Neisser, 2000; Larsen et al., 2002). For example, Larsen et al., (2002) examined autobiographical memories in Polish-Danish immigrants who were monolingual Polish speakers until arriving in Denmark. A higher incidence of Polish autobiographical memories were reported for the lifetime period arriving in Denmark, but decreased over time as participants had greater experience with the Danish culture and language. Similar results have been reported by

Marian & Neisser (2000) who examined autobiographical memory in Russian-English bilinguals, using cue words in English and Russian on separate sessions. For each session, autobiographical memories were linked with language of encoding, with Russian word prompts facilitating memory retrieval from the Russian period of the participants' lives and vice versa in English. Marian & Kaushanskya (2004) provide further evidence towards the autobiographical knowledge base being affected by language and culture. Depending on the language of cue word, bilinguals aligned themselves with the cultural norms; for example, they used more individualistic words with English memory recall compared to more collectivist words in Russian recall. Intriguingly, memories in the participants' L1 Russian were rated, as less positive than the L2 English memories, indicating that emotionality of memories were different in each language. Emotional intensity of memories did not differ between languages. Although the authors examined emotional intensity, they did not provide criteria for how they defined intensity, therefore emotional intensity and valence may not have been dissociated.

The bilingual autobiographical memory studies suggest language could be tied to the autobiographical knowledge base, but none have examined the hierarchical structure of autobiographical memories between the first and second languages of the bilinguals. This is an important question to address, as emotion is interlinked with autobiographical memories and has been differentially implicated in the first and second language of a bilingual. Furthermore, emotional valence has been differentially associated with L1 versus L2 for autobiographical memory retrieval. Yet, the relationship between emotional valence and memory structure has not been explored in bilinguals. As arousal can modulate memory retrieval, emotional arousal may differ between languages and memory.

Current Study

The present study examines autobiographical memory structure in Welsh-English bilinguals based on memory retrieval associated with positive and negative cue words. According to Conway & Pleydell-Pearce's (2000) self-memory system theory, we hypothesise that memories will be structured hierarchically (specific>general>timeline). We will test the hypothesis that more specific memories will be retrieved for L1 compared to L2, based on a higher degree of emotionality associated with L1. Also, we address the discrepancy that emotional arousal can be heightened in L1 but also in L2. We examine the emotional arousal of memories in each language to determine whether proficiency and age of acquisition modulate emotional arousal in L1 compared to L2 memories. All bilinguals in our study are highly-proficient Welsh-English bilinguals, but differ in their language dominance, which allows us to examine whether proficiency can explain the divergent findings for arousal in L1 versus L2. Contrary to previous autobiographical memory studies which utilised late bilinguals in an immigration context, our study uses early bilinguals who were raised in a bicultural environment, which provides an additional element of control.

4.3 Method

Participants

One hundred and twenty eight Welsh-English bilingual speakers completed online questionnaires, relating to language background and bilingualism and emotion. Forty-five participants were selected from those who had agreed to be approached about follow-up studies. All participants were early bilinguals matched for age of acquisition for first and second language (4-8 years), based on a language background questionnaire (Thomas and Gathercole, 2007). Participants were allocated into three groups of 15, based on order of acquisition of Welsh and English, resulting in L1 Welsh (L2 English), L1 English (L2

Welsh), and simultaneous Welsh/English groups. Gender was balanced across groups, with a female majority ($N = 32$), and the age range varied from 18-35. Age range was matched between groups, $F(2,42)=1.13, p=.33$.

Measures

Language Background. The Language Background Questionnaire (LBQ, Thomas & Gathercole, 2007) is a self-report measure of language proficiency. Questions, presented in both Welsh and English, determined age of acquisition for each language, everyday language usage and perceived language ability.

Language proficiency. English fluency was assessed using the British Picture Vocabulary Scale (BPVS; Dunn, Dunn and Whetton, 1982). The BPVS is a standardized assessment of receptive vocabulary typically used to assess children's reading ability. Four pictures are displayed on each page of the test booklet, with one picture corresponding to a target word. A number of studies have used this as a measure of language proficiency in bilingual adults (Majerus, Poncelet, Van der Linden, & Weekes, 2008). Welsh fluency was assessed using the equivalent *Prawf Geirfa Cymraeg i Oedolion* (PG; Gathercole & Thomas, 2007). The PG is structured so that a target word corresponds directly to one picture out of a set of four, displayed on a computer screen. As the PG is in the process of being validated, no standardized norms are available. However, the words used in the test become increasingly harder (lower frequency) as the test progresses.

For the L1 Welsh group, proficiency scores for Welsh (L1) were greater than proficiency scores for L2 (English), $t(14)=-2.23, p=.04$. In contrast, for both simultaneous and L2 Welsh bilinguals, English proficiency scores were higher than Welsh proficiency scores, $t(14)=3.24, p=.01$ and $t(14)=6.50, p<.01$, respectively (see Table 1 for scores).

Table 1.

Mean scores for English proficiency (BPVS) and Welsh proficiency (PG) for all groups (SEs in parentheses).

	<i>n</i>	BPVS <i>M (SE)</i>	PG <i>M (SE)</i>
L1 Welsh	15	91.16 (1.10)	94.13 (.95)
Simultaneous	15	93.29 (1.25)	87.57 (1.60)
L2 Welsh	15	93.70 (.83)	83.33 (1.35)

Emotion questionnaire: Bilingualism and Emotion Questionnaire (BEQ; Dewaele & Pavlenko, 2001). The Bilingualism and Emotion questionnaire was used to assess self-reported emotional intensity and emotional expression (use of swear words and taboo words) in each language of the bilinguals. The questionnaire was presented online bilingually, and consisted of 34 subjective statements and questions. The majority of questions and statements are scored on a Likert scale from 0 (not strong) to 5 (very strong). An example statement is: ‘Emotion felt using Welsh taboo words’, of which the participant rates the strength of the emotion, on a scale (0= not strong to 5=very strong). To assess emotional expression in Welsh vs. English, we combined the average scores on anger expression, swear words, intensity of taboo words and deepest feelings, for each language separately. The BEQ has been used to assess strength of swear words in each respective language of a bilingual (Dewaele, 2004), and effect of age of acquisition on processing emotion words (Dewaele & Pavlenko, 2002).

Autobiographical memory test (AMT, Williams & Broadbent, 1986).

The autobiographical memory test involves asking a participant to generate a specific memory related to an emotional (positive or negative) cue word inserted at the end

of a standard sentence, ‘Can you think of a specific time you were, e.g. ‘happy’. If the memory type generated was not specific, the experimenter would probe through asking, “do you have a specific example”? Words were presented on 6 x 4 inch cue cards with the target words written in capital letters. We used Welsh and English versions of the autobiographical memory test (ABT) to determine whether memories recalled in each language were specific (more vivid recall, specific location), general (less vivid recall, associated with a particular on-going event) or associated with a specific time-line (less vivid recall, associated with a particular series of events with a clear end-point, e.g. A-levels). For the autobiographical test, we created two words lists, comprised of six positive and six negative words, in Welsh and used the English translation equivalents for the English version. To ensure memory retrieval was not facilitated by familiarity of a previously presented translation equivalent, word lists were counterbalanced, and words presented randomly, between and within participants (see Chapter 5 for experimental control and procedures).

AMT Scoring

Two independent bilingual Welsh/English raters coded the memory types, as specific, general or time-line (lifetime), corresponding to Conway & Pleydell-Pearce (2000)’s model. Intraclass correlations were used to assess coding reliability. Agreement between the raters for all memory types in Welsh and English was $< .79$. As inter-rater reliability was high, final scores for memory types were computed through averaging the ratings of both independent raters for each memory type in each language.

Pre-experimental ratings and controls for word stimuli.

Two versions of the Welsh and English word lists were rated for valence and arousal from participants not taking part in the AMT, prior to the experiment (for procedure and scoring see appendix b). Welsh and English word lists were matched for frequency,

emotional intensity, valence and length, $F(1, 47)= 1.03, p=. 32$; $F(1,46)=.02, p= .90$; $F(1, 46)= .02, p= .90$; $F(1, 47)=.21, p=.65$, respectively (See appendix b, for mean scores and valence ratings).

Emotional Arousal/ Intensity

We hypothesised that emotional arousal associated with participants' retrieved memories would differ between L1 and L2, group and valenced cue words. Two independent raters scored the emotional arousal associated with retrieved memories for positive and negative cue words. The emotional intensity of retrieved memories was scored on a scale between 1 (very relaxed/ bored/ sleepy/ low arousal) to 9 (jittery/ excited/ frenzied/ high arousal), consistent with the arousal dimension of the Affective Norms for English Words (ANEW; Bradley & Lang, 1999). Inter-rater reliability for emotional arousal between Welsh and English autobiographical memories was high with an ICC of .79 for Welsh and ICC of .81 for English. An average arousal score was computed for each participant for positive cue words in English, negative cue words in English, positive cue words in Welsh and negative cue words in Welsh. Finally, as the inter-rater reliability was high, we averaged both raters' scores for emotional arousal of memories in Welsh and English separately.

Procedure

The Language Background and Bilingualism and emotion questionnaire were both presented online, with all questions presented in both languages. For the autobiographical memory test, participants attended two separate testing sessions, of which one was conducted in Welsh and the other in English, by the experimenter (LH) who was fully bilingual. Within the Welsh session, the PG and Welsh Autobiographical memory test were conducted through the medium of Welsh. The remaining assessments in the English session were conducted in English. The order of the sessions was counterbalanced to minimize any experimental confounds.

4.3.1 Results

Bilingualism & Emotion Questionnaire

Emotional expression in Welsh vs. English. To assess emotional expression in Welsh and English, we combined the average scores on anger expression, swear words, intensity of taboo words and deepest feelings, for each language separately. We ran ANOVAs for group x Welsh emotional expression, and group x English emotional expression. Groups differed in their self-reported use of Welsh emotional expression, $F(2, 42) = 14.27, p < .001, \eta^2 = .41^1$. As predicted, for all groups there was a higher use of emotional expressions in L1 than L2. Planned comparisons using Bonferroni correction revealed the L1 Welsh group used the most Welsh emotional expression ($M = 3.55, SE = .17$) compared to the simultaneous group ($M = 2.82, SE = .22, p = .02$), and the L2 Welsh group ($M = 2.22, SE = .17, p < .001$).

Groups differed in their self-reported use of English emotional expression, $F(2, 42) = 9.60, p < .001, \eta^2 = .31^2$. L2 Welsh bilinguals used more English emotional expression ($M = 4.20, SE = .21$) than both simultaneous ($M = 3.38, SE = .21, p = .02$), and L1 Welsh bilinguals ($M = 2.93, SE = .21, p < .001$).

¹ When adding Welsh and English proficiency scores into the ANOVA model as covariates, there is still a main effect of group, $F(2, 40) = 6.76, p < .01, \eta^2 = .25$, replicating the results reported above.

² After adding Welsh and English proficiency scores into the ANOVA as covariates, the main effect of group remains, $F(2, 40) = 6.18, p = .01, \eta^2 = .24$, consistent with the results reported above.

4.3.2 Autobiographical Memory

We examined the memories retrieved for positive and negative cue words in both Welsh and English. Memories associated with the positive and negatively valenced cue words were categorized as specific, general or timeline, separately for Welsh and English.

We ran a 3 (group: L1 Welsh, simultaneous, L2 Welsh) x 3(memory type: specific, general, timeline) x 2 (language: Welsh vs. English) x 2 (valence) repeated measures ANOVA to determine whether memory types differed between languages, group and across valence³. Memory types differed, with a main effect of memory type, $F(2, 42)=149.96$, $p<.001$, $\eta^2 = .78$. Bonferroni post-hoc tests revealed that specific memories ($M=3.88$, $SE=.16$) were the most highly recalled followed by general ($M=1.30$, $SE=.12$), and timeline ($M=.59$, $SE=.06$), significance $p < .001$. Recall of memory types did not differ by group, $F(2, 42)=.78$, $p=.54$, $\eta^2 = .04$), nor by language, $F(2, 42)=.24$, $p=.62$, $\eta^2 = .01$. However, valence affected recall of memories, $F(2, 42)=9.68$, $p=.003$, $\eta^2 = .19$. Bonferroni post-hoc tests revealed that a higher proportion of autobiographical memories were retrieved for positively valenced cue words ($M=1.97$, $SE=.02$) than memories associated with negatively valenced cue words ($M=1.88$, $SE=.03$). There was no interaction between valence x group, $F(2, 42)=.72$, $p=.49$, $\eta^2 = .03$, nor memory x valence, $F(2, 42)=.66$, $p=.52$, $\eta^2 = .02$. However, there was a significant interaction between memory type x valence x group, $F(2, 42)=4.04$, $p=.01$, $\eta^2 = .16$.

To separate the effects of group on valence and memory, we ran a repeated measures ANOVA for memory (3) x language (2) x valence (2) for each group separately. All groups (L1 Welsh, simultaneous, L2 Welsh bilinguals) replicated the above results for memory types, $F(2, 14)=46.99$, $p<.001$, $\eta^2 = .77$, and $F(2, 14)=33.29$, $p<.001$, $\eta^2 = .70$, $F(1, 14)=$

³ Although proficiency scores differed between L1 and L2 for each group, we did not covary proficiency due to the decrease in power associated with adding two covariates. Indeed, when preliminarily adding English and Welsh proficiency as covariates in the ANOVAs, power decreased from $\beta=1.00$ to $\beta=.67$ for memory type.

88.45, $p < .001$, $\eta^2 = .86$, respectively. As reported earlier, specific memories were recalled most frequently, followed by general and time-line memories. For emotional valence of memory types, recall was similar for both positive and negative memories in L1 Welsh and simultaneous bilinguals, $F(2, 14) = 1.44$, $p = .25$, $\eta^2 = .09$, and $F(2, 14) = 14$, $p = .12$, $\eta^2 = .17$. However, there was a significant interaction between valence x memory for the L2 Welsh bilinguals, $F(2, 28) = 8.66$, $p < .01$, $\eta^2 = .38$. To explore this interaction further we ran paired t-tests for memory type and valence for L2 Welsh bilinguals for each language (Welsh and English). For autobiographical memories retrieved for English cue words (L1), there were no differences between positive and negative valence for specific, general nor timeline memories, $t(14) = -.11$, $p = .91$; $t(14) = 1.24$, $p = .24$; $t(14) = .98$, $p = .35$ respectively. However, for the valenced Welsh cue words (L2), there was a higher proportion of specific memories retrieved for negative compared to positive Welsh cue words, $t(14) = -3.29$, $p = .01$. Similarly, a higher incidence of timeline memories were elicited for positive compared to negatively valenced cue words, $t(14) = 2.94$, $p = .01$ (see Figure 1)⁴.

⁴ Higher scores on Welsh proficiency predicted a greater proportion of specific memories associated with positive cue words in Welsh, $R^2 = .10$, $F(1, 43) = 4.84$, $p = .03$; $r(45) = .32$, $p = .03$, but on no other memory types, all F 's < 1.59 , all p 's $< .52$. In contrast, lower scores on Welsh proficiency predicted fewer general memories associated with positive cue words in English, $R^2 = .10$, $F(1, 43) = 5.56$, $p = .02$; $r(45) = -.34$, $p = .02$, but on no other memory types, all F 's < 1.48 , all p 's $< .97$.

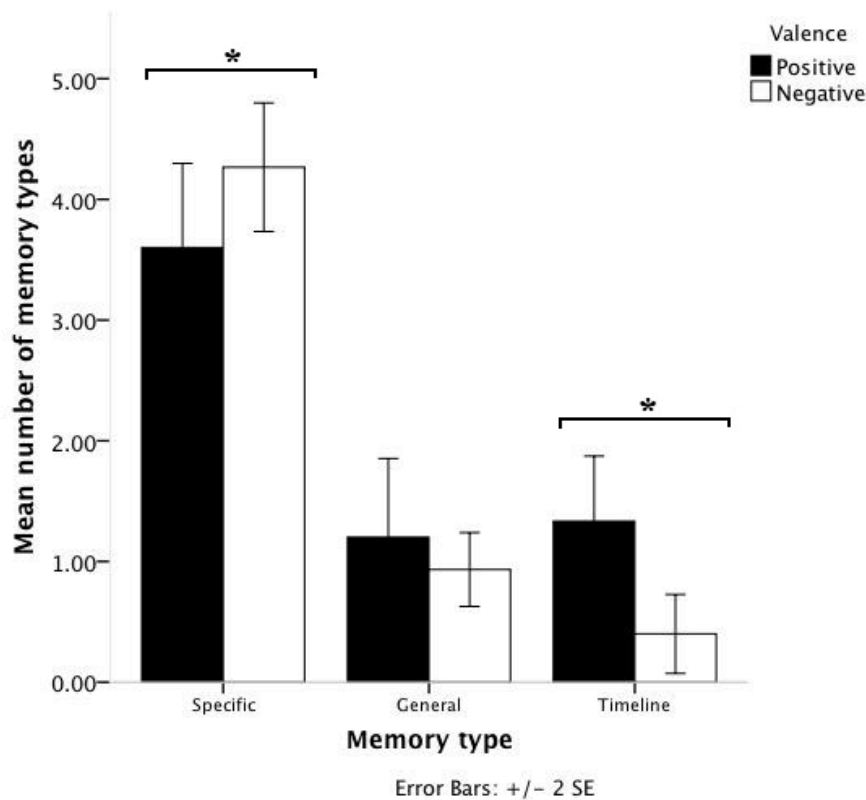


Figure 1. The interaction between valence and memory type for L2 Welsh bilinguals, in Welsh.

4.3.3 Emotional Arousal

To determine whether emotional arousal of participants' autobiographical memories differed by language or group, we ran a 2 (language: Welsh versus English) x 2 (emotional arousal associated with positive/ negative cue words) x 3 (group: L1 Welsh, simultaneous, L2 Welsh) repeated measures ANOVA. The emotional arousal of memories did not differ between languages, $F(1, 42) = .22, p = .64, \eta^2 = .01$, Welsh ($M = 5.68, SE = .06$), English ($M = 5.65, SE = .06$), nor across group (L1 Welsh, simultaneous, L2 Welsh), $F(1, 42) = 1.16, p = .$

32, $\eta^2 = .05$. Emotional arousal of memories was similar between languages, as there was no interaction between language and valence, $F(2, 42) = <.01, p = .99, \eta^2 = <.01$ (see figure 2). Emotional arousal differed for autobiographical memories associated with positive and negative cue words, $F(1, 42) = 214.63, p < .001, \eta^2 = .84$. Pair-wise comparisons using Bonferroni reveal memories retrieved for negatively ($M = 6.24, SE = .07$) valenced cue words elicited greater emotional arousal than positively ($M = 5.08, SE = .06$) valenced cue words, $p < .001$. This did not differ between groups, as there was no interaction between arousal and group, $F(2, 42) = .91, p = .41, \eta^2 = .04$.

To elucidate whether proficiency scores predicted the level of emotional arousal associated with L1 and L2, we ran regression analyses with Welsh and English proficiency scores as predictor variables. Welsh proficiency did not predict the strength of emotional arousal for Welsh, $R^2 = <.001, F(1, 88) = .001, p = .97$ nor English languages $R^2 = .001, F(1, 88) = .01, p = .91$. Similarly, English proficiency was not a significant predictor for strength of emotional arousal in Welsh, $R^2 = .001, F(1, 88) = .001, p = .97$ or English $R^2 = .003, F(1, 88) = .26, p = .61$.

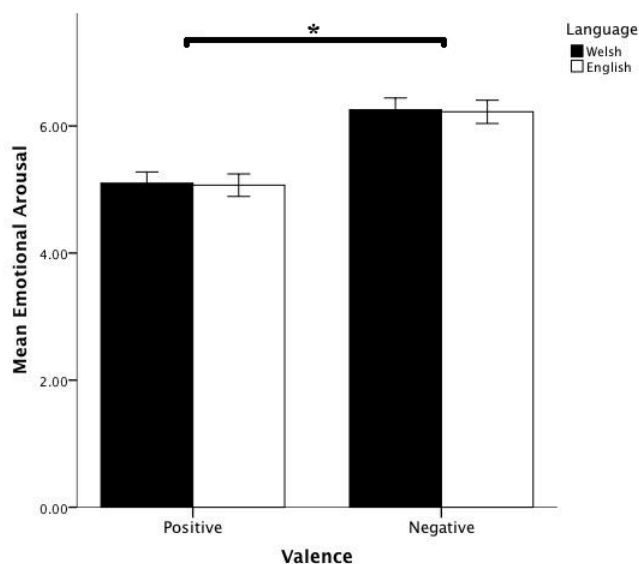


Figure 2. The average emotional intensity scores for positive and negative valence in L1 and L2.

4.4 Discussion

Our study was the first to measure the hierarchical structure of autobiographical memory and integration of autobiographical memory and valence in early bilinguals. The same proportion of specific, general and timeline memories were retrieved for the first and second languages of L1 Welsh and simultaneous bilinguals. However, the L2 Welsh bilinguals displayed a different pattern of memory retrieval for positive and negative valence in their second language. This could be due to proficiency, cultural factors (Hadden, Ward, Mills, Davies & Bentall, under revision) or how emotion words are represented in the emotional lexicon (see Marian & Kaushanskaya, 2008), which we will discuss further below.

We also examined whether emotional intensity would differ for autobiographical memories associated with L1 and L2, when controlling for age of acquisition but not proficiency. Surprisingly, proficiency differences between L1 and L2 did not modulate the strength of emotional arousal between L1 and L2. In contrast to previous literature, which reported enhanced emotional arousal in L1, which was related to increased proficiency (Harris, 2004; Anooshian & Hertel, 1994; Eilola & Havelka, 2010). Our study indicated that regardless of language proficiency, memories related to negatively valenced compared to positive cue words were associated with greater emotional arousal. We will discuss interpretations related to these findings in turn.

4.4.1 Memory retrieval

Based on the bilingual recall literature (Ayciegi-Dinn & Caldwell-Harris, 2004, 2009; Marian & Kaushanskaya, 2004, 2008) and clinical findings (Williams & Dritschel, 1992; Kaney, et al., 1999), which suggest language and emotion influence autobiographical memory, we expected a higher proportion of specific memories associated with L1 compared to L2. This was only the case for the L1 Welsh and simultaneous groups who retrieved a

similar proportion of memory types for L1/ L2. Our study was the first to examine if language affects the structure of autobiographical memory, and our sample of highly proficient, early bicultural bilinguals did not differ in the proportion of memory types retrieved. All groups elicited the same hierarchical memory structure across languages, (specific>general>timeline) despite the proportion of memories retrieved being modulated by valence in their second language for the L2 Welsh group.

Consistent with Ferre et al., (2010), our results support the position that memory retrieval is not affected by language dominance (L1 Welsh/ simultaneous/ L2 Welsh). Our results also indicate that bilingual memory is structured hierarchically (specific>general>timeline) similarly for both L1 and L2. This supports the self-memory systems theory proposed by Conway and Pleydell-Pearce (2000), which suggests that autobiographical memory is structured hierarchically based upon structural knowledge schemas. Our results extend previous accounts of memory retrieval in bilinguals, through controlling for age of language acquisition and measuring the structure of autobiographical memory retrieval. Marian & Neisser (2000) and Marian & Kaushanskya (2004) reported greater recall for memories in the language of memory encoding.

Although these previous bilingual autobiographical memory studies (Marian & Kaushanskya, 2004; Larsen et al., 2002) examined memories related to particular lifetime periods (before and after immigration), they did not examine the structure of autobiographical memories between languages. A strength of our study is the control on age of acquisition, which enables us to compare autobiographical memories between groups that are not confined to particular lifetime periods. In turn, this allows us draw conclusions about the structure of bilingual autobiographical memories.

Our study also measured how the structure of autobiographical memory types was affected by valenced cue words. Consistent with recall studies such as Eilola et al., (2007)

and Ferre et al., (2010), memory retrieval for emotional cue words did not differ between languages for the L1 Welsh nor simultaneous bilinguals. However, the L2 Welsh group showed differential memory retrieval based on valence, but only for their second language. A negative bias was evident for specific memories, whereas positive cue words elicited a higher proportion of timeline memories. The only baseline difference between groups was Welsh proficiency, of which L2 Welsh bilinguals had the lowest proficiency, but were still highly proficient. A bilingual processing model such as Kroll & Stewart (1994) suggests that bilinguals with lower levels of proficiency in their L2 will access a conceptual representation through their first language. However, both L1 Welsh and L2 Welsh bilinguals had lower proficiency scores in their L2, but only L2 Welsh bilinguals showed differential memory retrieval based on valence. We propose that the higher proportion of negative specific memories retrieved for L2 Welsh bilinguals was a function of reduced Welsh proficiency. Indeed, higher Welsh proficiency scores predicted a greater proportion of specific memory types associated with positive cue words, in Welsh (See footnote 5). Therefore the negative bias for specific memories (and decreased proportion of specific memories for positive) for the L2 Welsh bilinguals is likely to reflect reduced Welsh proficiency. Furthermore, the L2 Welsh bilinguals had a larger discrepancy between their proficiency scores for L1 and L2 compared to the simultaneous and L1 Welsh bilinguals (see table 1), which could account for why the other bilingual groups do not show these memory types differences between languages. However, the greater proportion of timeline memories for positive cue words was not associated with proficiency.

Although bilinguals were matched for age of acquisition, cultural differences may account for valence affecting the proportion of positive timeline memories retrieved for the L2 Welsh bilinguals, similar to effects of culture on memory for Marian & Kaushanskya (2004). All bilinguals were raised in North-West Wales, which has a higher proportion of

first language Welsh speakers, (~74%, Office for National Statistics, 2001). However, the L2 Welsh bilinguals learned Welsh in school, and thus may not identify as being from the Welsh culture. Indeed, L2 Welsh bilinguals' had higher explicit Welsh cultural identity scores compared to simultaneous and L1 Welsh bilinguals (Hadden, Ward, Mills, Davies & Bentall, 2013, under revision). The higher explicit cultural identity/ affinity scores for L2 Welsh bilinguals could account for why more positive timeline memories were recalled for Welsh compared to English cue words- perhaps due to higher salience for positive experiences. Similarly, Marian & Kaushanskya (2008) found that late Russian-English bilinguals used more positive words in their L2- perhaps due to cultural differences. However, these authors did not examine the structure of autobiographical memories between L1 and L2.

4.4.2 Emotional arousal of memories

Emotional arousal of memories did not differ between groups (L1 Welsh/ simultaneous/ L2 Welsh) or language (Welsh/ English). Our results indicate that the level of proficiency in L1 or L2 did not modulate the level of emotional arousal for memories retrieved in L1 or L2. Although there were proficiency differences between L1 and L2- with L1 eliciting higher proficiency scores; surprisingly, these scores did not modulate the strength of emotional arousal. Thus, discrepancy for emotional arousal in previous studies could be related to proficiency differences (e.g. Harris, 2004; Eilola & Havelka, 2010; Anoshian & Hertel, 1994) rather than heightened emotional arousal associated with L1.

Consistent with electrodermal accounts of emotional processing in bilinguals (Aycicegi & Harris, 2004; Eilola & Havlenka, 2010), negative emotion words produced the greatest level of emotional arousal, but for both L1 and L2. The greater level of negative arousal may be related to heightened emotional processing for negative information (Kensinger & Corkin, 2003; Bernsten, 2002), and thus deeper initial memory encoding.

Indeed, Schrauf & Sanchez (2010) reported a greater preponderance of negative words represented in the monolingual emotion lexicon of Spanish and English participants. Evolutionary models of emotion (e.g. Bradley, Codispoti, Cuthbert, & Lang, 2001) are consistent with languages not displaying differences in memory retrieval nor emotional arousal.

Evolutionary accounts such as Bradley et al (2001) suggest emotion (arousal, valence) is represented in two orthogonally distinct motivational systems: appetitive and defensive. The appetitive system responds to situations related to survival (reproduction, eating) and the defensive system is mediated by threat detection. The function of autobiographical memories is related to problem-solving (Goddard, Dritschel & Burton, 1997) and social judgments (Bluck, Alea, Habermas & Rubin, 2005), which could be linked to both defensive and appetitive systems. If these motivational systems functioned differentially between languages, individuals may have poorer problem-solving and social judgments in their second language.

Recent research on decision-making has reported the opposite (Keysar, Hayakawa & An, 2012) with late second language learners making fewer biased decisions in a gambling-task. This suggests the second language can facilitate cognitive processes, when proficiency is not controlled. Similarly, Marian & Kaushanskya (2008) and Aycicegi & Harris (2004) have reported that greater degree of emotionality in the second language may serve as a protective factor. Thus, emotional arousal for L2 may be heightened as an evolutionary strategy to provide similar emotional salience between languages. We argue that not finding differences between languages for arousal is a function of early age of acquisition, and high levels of proficiency. Future studies could explore whether the emotional arousal of autobiographical memories differs between languages for early versus late bilinguals. As later age of acquisition has been linked to heightened emotional arousal in L1 (Eilola &

Havlenka, 2010; Aycicegi & Harris, 2004) and different structural organization of the brain (Perani et al., 1998), fMRI could be used to assess the functional organization of autobiographical memories and emotion between languages.

In summary, our study is the first to examine autobiographical memory retrieval and structure for emotional cue words in early bilinguals, matched for the age they learned their second language. Our study also examined the effects of emotional arousal on memory retrieval. Our findings suggest the tendency to recall specific>general> timeline memories do not differ between L1 or L2 for L1 Welsh and simultaneous bilingual groups matched on proficiency and cultural identity. However, valence modulated the proportion of types memories retrieved in L2 for highly proficient L2 Welsh bilinguals, suggesting the emotional lexicon is differentially organized for L2. This finding could be related to differences in cultural identity or larger proficiency differences between L1/ L2. Across groups, a negative bias is apparent for emotional arousal associated with memories retrieved for negative cue words, which is consistent between languages.

Surprisingly, emotional arousal did not differ between L1 and L2, regardless of proficiency differences. This finding could have implications for psychiatric therapy with bilingual patients, suggesting that therapy in either language could be as effective. On the whole, these results suggest that neither bilingual memory retrieval nor emotional arousal for L1 Welsh and simultaneous bilinguals differ between languages. A limitation of the study was not measuring language of encoding, although this would have proved difficult as the bilinguals were subject to frequent interactions in both Welsh and English daily. However, this would allow a clearer comparison between other bilingual autobiographical memory studies (Marian & Neisser, 2000; Larsen et al., 2002). Future studies could include electromyography to provide an online measure of emotional affect, whilst recalling memories; or electrodermal (skin conductance response) studies for a more sensitive

measure of emotional arousal, related to autobiographical memory retrieval. Additionally, emotional arousal associated with autobiographical memories could be assessed in bilingual psychiatric patients, to see whether the structure of memory types and arousal is modulated by cognitive biases and blunted affect.

CHAPTER 5

Anxiety and depression modulate brain activity to meaningful and emotional words¹.

5.1 Abstract

The maintenance of anxiety and depressive disorders is related to cognitive and emotional biases. Yet, the relative contribution of semantics and emotion in sustaining these biases remain entangled. The current study used event-related potentials to address how people who score low versus high on scales of anxiety/ depression (AD) process valenced semantic and emotional words. Emotionally valenced targets (positive, negative or neutral) were primed to be semantically and affectively related; semantically unrelated; or affectively unrelated. When all participants were considered together, semantic and affective conditions modulated brain activity differentially, with an N400 effect for semantics and an LPC for emotion. However for participants who scored high on AD, interactions with valence significantly influenced both semantic and emotional processing reflected by the N400 and LPC. We propose that the LPC to semantic incongruencies is a neurophysiological marker for abnormal processing of positively valenced stimuli for anxiety/depression. Difficulty integrating positive meaning is consistent with low positive affect, negative schemas and could be associated with maintaining the disorders.

¹ This Chapter, along with revisions, has been submitted to Social Affective Cognitive Neuroscience for publication.

5.2 Introduction

The way the brain processes meaning and emotion in language is a topic of considerable interest in the field of cognitive neuroscience. Both semantic integration and emotion evaluation have been examined with non-psychiatric populations, using behavioural (Havas, Glenberg & Rinck, 2007; Lai, Hagoort, & Casasantro, 2012) and electrophysiological measures (Delaney-Busch & Kuperberg, 2013; Kissler, Assadollahi & Herbert, 2006). However, few studies have examined combined semantic and emotion processing in people with psychiatric disorders. Psychiatric disorders such as anxiety and depression are associated with cognitive biases for threat-related words /pictures (Richards & French, 1992; Bradley, Mogg, White, Groom & de Bono, 1999) and negative information (Watson, Clark & Carey, 1988). Whilst the core feature of anxiety is fear and an elevated response bias to threatening information (Beck & Clark, 1997; Li, et al., 2008); the core feature of depression is pervasive low mood, which is related to reduced motivation and appetite (Beck, 2008).

Although both anxiety and depression have a different clinical presentation, the maintenance of each is associated with negative thought patterns and difficulty with emotion regulation (Beck, 2008; Beck & Clark, 1997; Greening, Osuch, Williamson & Mitchell, 2013). Emotional responses associated with such thought patterns are postulated to strengthen the negative schemas (Beck, 2008). Neuroimaging studies provide converging evidence for an emotion bias in anxiety and depression, with heightened amygdala activation for negative words (Siegle, Steinhauer, Thase, Stenger & Carter, 2002) and threat-related pictures (Bishop, Duncan & Lawrence, 2004). Similarly, van Wingen et al (2011) report enhanced activity in the amygdala and in the left inferior frontal lobe (associated with semantic integration) for labeling negative faces. Conversely, positively valenced words are

associated with attenuated amygdala activation (Canli et al., 2004; Siegle, Steinhauer, Thase, Stenger & Carter, 2002), consistent with reduced reactivity for positive information (positive attenuation hypothesis, Rottenberg, Gross & Gotlib, 2005). The differential responses to positively and negatively valenced stimuli could outline dysfunction in emotional processing or difficulty with integrating valenced semantic concepts. An fMRI study examined how people with depression processed valenced (positive/ negative/neutral) semantic concepts (Sass et al., 2012). Severity of depression was related to decreased activation of the dorsolateral prefrontal cortex (associated with executive control & mood regulation, Bae et al., 2006) and the amygdala to positively valenced stimuli, suggesting mood interacts with semantic information. However, Sass et al., (2012) did not examine semantic and affective processing separately, thus the relative contribution of semantics and emotion remained entangled. The present study uses a semantic and affective word-priming paradigm to disentangle the relative effects of abnormal semantic and affective processing in people with depression and anxiety.

5.2.1 Semantic integration & mood induction

Theories of embodied cognition suggest perception of emotional stimuli can be altered depending on current mood and facial expression (Niedenthal, 2007). Havas et al., (2007) found facilitated reaction times for non-psychiatric participants when facial expressions and sentence valence were congruent (e.g. positive- smile vs. negative-frown). The effect of mood on semantic integration has also been examined in a number of electrophysiological studies (Egidi & Nusbaum, 2012; Moreno & Vasquez, 2011; Chwilla, Virgillito & Vissers, 2011).

A well-established ERP component associated with the integration of contextually-meaningful stimuli the N400 (see reviews by Kutas & Federmeier, 2000, 2011) is also modulated by mood. Both positive and negative moods have been related to modulation of

the N400 amplitude (Egidi & Nusbaum, 2012; Moreno & Vasquez, 2011). Specifically, mood congruent stimuli (positive mood-positive valence; negative mood-negative valence) have been associated with a reduced N400 (Egidi & Nusbaum, 2012), indicating that semantic integration is affected by current mood. Federmeier, Kirson, Moreno & Kutas (2001) found positive mood facilitated integration of more distantly-related semantic category members (reduced N400), compared to neutral mood. However, negative mood and semantic integration were not examined. Compared to induced positive mood, negative mood has been associated with reduced amplitude of the N400 for stimuli of opposite valence (Chwilla et al., 2011), and for distantly-related semantic categories (Pinheiro et al., 2013). Despite mood modulating semantic integration, these studies did not examine psychiatric traits (Chwilla et al, 2011; Pinheiro et al., 2013), and mood was artificially induced. Since psychiatric and non-psychiatric participants may have qualitatively different processing styles, how patients/ people high on trait-anxiety/ depression may interpret semantic and emotional information remains unanswered.

5.2.2 Semantic Integration in depression

Deldin et al., (2006) examined how people with depression, dysthymia (chronic mood disorder), and controls integrated semantically related and unrelated words with preceding neutral sentences. Compared to patients with depression and controls, patients with dysthymia had a larger amplitude of the N400, indicating greater difficulty integrating semantic information into its preceding context. Using a similar task, Iakimova et al., (2009) found controls and people with depression had similar N400 amplitudes for semantically incongruent information, but the N400 occurred later for the patients with depression. Despite, depression being associated with both cognitive and emotional deficits, neither Deldin et al., (2006) nor Iakimova et al (2009) examined how patients integrated emotional information into a semantic context. This question was partially addressed by Klumpp et al.,

(2010) who examined how patients with depression, dysthymia, schizophrenia and controls integrated emotional information into a preceding neutral context. Patients with schizophrenia were the only group to exhibit a larger N400 for negatively valenced stimuli. However, an ERP component associated with emotion evaluation, the late positive component, LPC, was not measured (for reviews see: Kissler et al., 2006; Citron, 2012).

The LPC is a positively-deflecting waveform usually occurring between 500-800 ms (Citron, 2012), and is indexed by stimuli differing in valence. The LPC has been reliably elicited in paradigms similar to Klumpp et al., (2010), who use neutral sentence frames, and following emotional and neutral words (e.g. Delaney-Busch & Kuperberg, 2013; Holt et al., 2008). A larger amplitude of the LPC occurs for both pictures with differing valence (Hajcak & Olvet, 2008) and words (Carretie et al., 2008). The LPC is typically larger for both positive and negatively valenced stimuli than neutral (Hajcak, Weinberg, MacNamara & Foti, 2012). Although, studies have reported a larger LPC for negative (Kanske & Kotz, 2007) or positively-valenced stimuli (Kissler, Herbert, Winkler & Junghofer, 2009).

5.2.3 Emotional processing in patients with anxiety & depression

An ERP component with similar timing and distribution to the LPC is the P300 (a positively going waveform, that peaks-around 300ms). Both the LPC and the P300 relate to attentional resources, albeit that the LPC is only elicited with emotional stimuli. The P300 occurs for memory updating of frequent vs. rare stimuli (Donchin & Coles, 1988). The rare compared to the frequent stimuli elicits a greater P300 response (an oddball task). Emotional processing studies with patients have typically examined attentional allocation to emotional stimuli (Ilardi, Atchley, Enloe, Kwasny & Garratt, 2007; Li, Zinbarg & Paller, 2007). A greater P300 is often elicited for negatively valenced stimuli compared to positive and neutral in people with depression (Nandrino, Dodin, Martin & Henniaux, 2004). Similarly, participants with high trait anxiety or phobic patients, produce a greater P300 effect for

threat-related and negative words compared to participants without trait anxiety or phobia (De Pascalis et al., 2004; Miltner et al., 2005). As the majority of these studies used an oddball task, attentional updating for frequent compared to rare emotional stimuli was examined. Consequently, the emotional biases associated with anxiety and depression are apparent for emotional words and faces. Since maintenance of these disorders is associated with cognitive and emotional biases, it is fundamental to understand the respective processing of semantics and emotion, for both treatment and illness progression. Yet, the separability of semantics and emotion in these disorders has not been established, which is essential to understand symptom maintenance.

Current study aims & predictions

The current study addresses how people with low versus high trait depression and anxiety process semantic and affective stimuli. Based on the low positive affect and negative biases associated with anxiety and depression, we hypothesise negatively valenced stimuli will provide the greatest facilitation with semantic integration (smaller N400) and the largest LPC emotion effect. In addition based on the low positive affect and reduced neural activity for positive words in anxiety/ depression, we hypothesise decreased N400 integration for positive related versus unrelated semantic word-pairs. As people with clinical anxiety & depression may have low mood, we expect interactions between semantics and emotionally valenced stimuli. We predict people low on trait anxiety/ depression will have similar amplitude of the N400 across all valence for semantic stimuli, but a larger emotional effect, LPC for negatively valenced affective stimuli.

5.3 Method

Participants

Thirty-eight individuals participated in the experiment (20 females). The majority of participants were recruited from the Bangor University student participant panel ($n=32$) and the remaining participants ($n=6$) were recruited through word-of-mouth. The age range varied from 18-36 ($M= 21.89$). All participants had corrected to normal vision, were native monolingual speakers of English, and all were right-handed. The School of Psychology ethics committee approved the study, and all participants provided informed consent.

Participants' current mood was measured using the positive and negative affect schedule (PANAS; Watson, Clark & Tellegen, 1988). The scale consists of 10 positive (e.g. 'proud') and 10 negative (e.g. 'jittery') adjectives, of which participants rated on a likert-scale, from one to five, the extent they currently felt that emotion.

Levels of trait anxiety and depression were measured using the hospital anxiety and depression scale (HADS; Zigmond and Snaith, 1983). The HADS consists of two subscales: anxiety and depression (Bjelland, Dahl, Haug & Neckelmann, 2002). A score between 8-10 on the respective subscale indicates a borderline case of anxiety or depression. A score above 11 has been associated with diagnostic criteria for anxiety and depression, and has been used as an indicator of trait anxiety and depression (Hamer et al, 1991). The high anxiety and depression group were pooled together for this study, due to co-morbidity of the disorders (Lamers et al., 2011).

Participants who scored above the borderline range (>10) for anxiety ($M=11$, $SE=1.04$) or depression ($M=10.57$, $SE=1.10$) were allocated to the high anxiety and depression group (High AD). Participants who scored below 5 on the anxiety ($M=4.8$, $SE=.37$) and depression ($M= 4.6$, $SE=. 37$) subscales were allocated to the low anxiety and

depression group (low AD) (Zigmond & Snaith, 1983). Groups were age matched (Low AD; $M=21.29$, $SE=.79$, High AD; $M=23.21$, $SE=1.30$), $t(29)=-1.40$, $p=.17$.

Experimental stimuli

Semantic and emotional processing were examined separately using written word-pairs in a prime – target priming paradigm. All words were rated for affective valence (Affective norms for English words; ANEW, Bradley & Lang, 1999), arousal, imaginability (MRC database; Coltheart, 1981), frequency (Brown-corpus; Kucera & Francis, 1967) and length (see chapter 5 for ratings and control within experimental conditions).

The stimuli consisted of 360 written prime-target word pairs (Table 1). One third of the pairs ($n=120$) were both semantically related and were of the same emotional valence, e.g. glory - triumph (S+E+). One third were semantically related but had a different emotional valence, e.g. defeat - triumph (S+E-), and one third were semantically unrelated but had the same emotional valence, e.g. family - triumph (S-E+). The targets consisted of 120 words classified by emotional valence (40 positive, 40 negative and 40 neutral). Note that the target stimuli were repeated across the three conditions such that ERPs were recorded to physically identical stimuli. Word-pairs were rated for semantic relatedness and separated into semantically related and unrelated conditions based on scores on the semantic rating scale. The semantic rating scale consisted of all word-pairs included in the experiment, and were rated on a Likert scale from 0 (semantically unrelated) to 3 (highly semantically related; see chapter 5 for further details.) Relationships between prime and target stimuli within a word pair were manipulated for semantic relatedness (Congruent/ Incongruent) and congruency for emotional valence (positive, negative, neutral).

Table 1.

Word-pairs (prime-target) that were both semantically and affectively related (S+ E+); semantically unrelated but affectively related (same valence, S- E+) and semantically related but affectively unrelated (different valence; S+ E-).

Congruent Word-pairs S+ E+	Semantically Unrelated Word-pairs S- E+	Emotionally Unrelated Word-pairs S+ E-	Targets
GLORY- TRIUMPH	FAMILY- TRIUMPH	DEFEAT- TRIUMPH	POSITIVE e.g. TRIUMPH
HARM- DANGER	UGLY- DANGER	THRILL - DANGER	NEGATIVE e.g. DANGER
ADVERT- LEAFLET	PROFILE- LEAFLET	ADVICE - LEAFLET	NEUTRAL e.g. LEAFLET

Procedure

Participants were seated 120 cm away from the monitor in a sound attenuated testing room in front of a Samsung LE-46A656 TV. A fixation cross was presented prior to the beginning of all word-pair trials. The fixation-cross remained on screen until the participant's first response. A variable inter-stimulus interval of 500-600 ms preceded the prime, followed by a jittered inter-stimulus interval of between 800 to 1000 ms before the target. Participants were asked to attend to both prime and target but respond with a button press (positive, negative or neutral) to the target. Following sixty word pairs, a 15 s animated video clip and break screen would be presented (See figure 1, for stimulus presentation). Button presses were counterbalanced so that side of response for positive and negative targets was counterbalanced across participants. Participants used their left thumb for the left

side, right thumb for right button press, and either thumb for centre button press (neutral targets). Stimuli were randomized so no identical word-pairs would be displayed on screen.

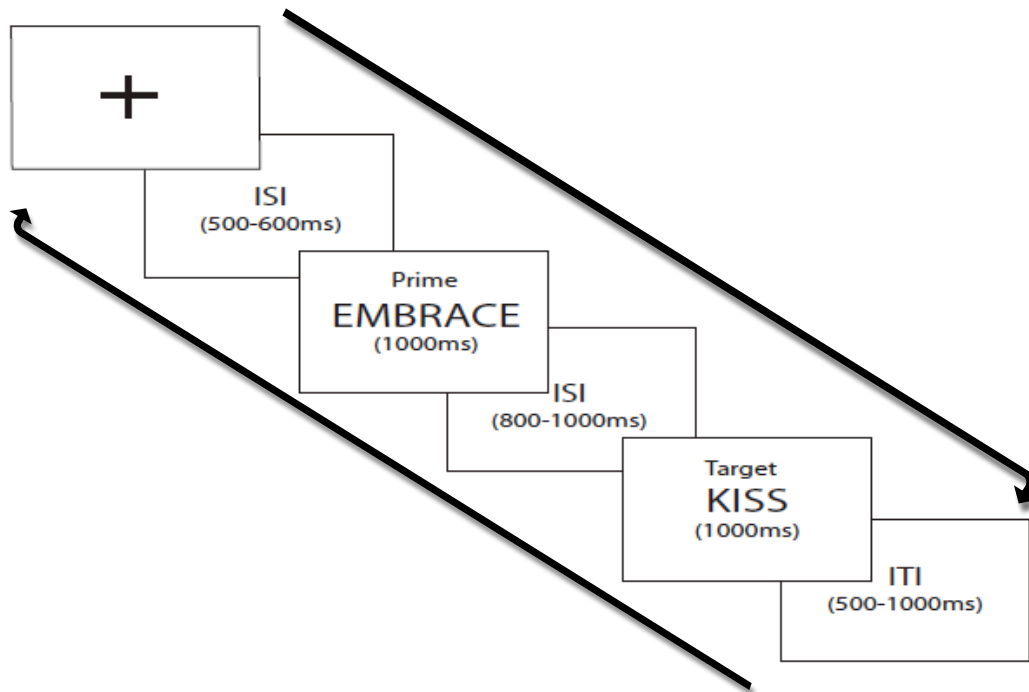


Figure 1. Presentation order of stimulus throughout the experiment.

Physiological recording, data acquisition, rejection & analysis

EEG data were recorded using pin-type AG-AgCl active electrodes attached to an elastic BioSemi head cap. Sixty-four electrodes were placed in standardized locations (frontal, fronto-central, temporal, parietal and occipital), consistent with the international 10-20 system. The electrooculogram (EOG) was measured for horizontal eye movements via an electrode placed on the right outer canthus. Vertical eye movements were measured using an electrode below the left eye, and after data acquisition creating a bipolar eye channel from FP1 (above the eye) and EOG1 below the left eye. Separate electrodes were placed on both the left and right mastoid to serve as a baseline measure of neuronal activity. EEG was sampled at 2048 Hz during recording and down-sampled offline to 512hz. Data were

amplified at a gain of 20,000 and recorded reference and filter-free using a BioSemi active 2 system. Offline, all electrodes were re-referenced to the average of left and right mastoids.

Eye blinks, muscle activity, biological noise and drift were identified offline through visual inspection of the EEG and ERP data. Artifact rejection was conducted on the epoched data individually for each participant using ERPLAB Toolbox, within EEGLAB (Delorme & Makeig, 2004) and run through MATLAB (version 7.9 R2009b; MathWorks, 2009).

Thresholds for detection of artifact for blinks, horizontal eye movement, drift, movement and muscle artifact were set individually for each participant (as recommended by Luck, 2005). Data from seven participants were excluded from data analysis due to excessive artifact or technical error (no differences between groups). For the remaining participants ($n=31$), on average, 13% of artifact was rejected across each trial for the Low AD group ($M= 184.41$, $SD= 152.76$). For the High AD group 23% of artifact was rejected across all trials ($M= 322.29$, $SD = 250$). The groups did not differ significantly on amount of artifact rejected, $t(20.61) = -1.80$, $p = .09$, equal variances not assumed.

ERPs were time-locked to the onset of the target word with a pre-stimulus baseline of 200 ms and epoch of 1000 ms. The time-window selected for the N400 semantic congruency effect was 350-500 ms (Kutas & Hillyard, 1984). Based on visual inspection (see Figure 3) the most pronounced LPC effect occurred between 570-770 ms for the emotion condition. The time windows for both the N400 and LPC were validated by conducting preliminary analyses using a series of 10 ms overlapping windows, to determine the onset and offset of condition effects. Based on previous literature (Hajcak et al., 2012; Hinojosa, Mendez-Bertolo, & Pozo, 2010) and visual inspection of the topographical head maps (see figure 4), twenty-one electrode sites from fronto-central regions and 16 posterior

electrodes were selected for analysis (see figures 2 & 4)². Mean amplitudes across the N400 and LPC time-windows were used for statistical analyses.

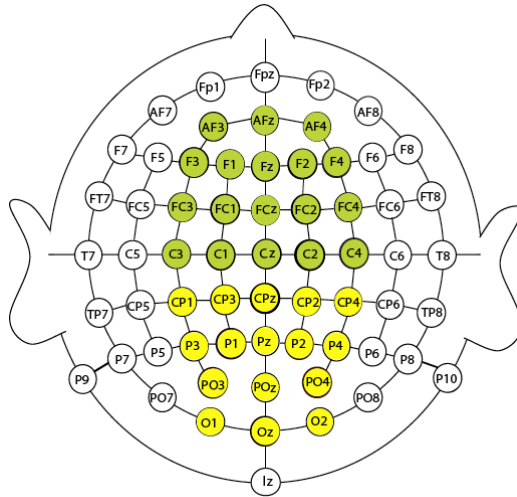


Figure 2. Head map displaying electrode sites selected for analyses.

5.4 Results

Behavioural & self-report ratings

PANAS. The low AD group had higher ratings for current positive mood ($M=33.29$, $SE=1.53$) than the high AD group ($M=28.71$, $SE= 1.87$), with a near significant difference, $t(29)=1.91$, $p=.07$. The HighAD group had a higher score for negative mood ($M= 13.50$, $SE=1.68$) compared to the LowAD group ($M=11.12$, $SE=.35$). However, this difference was not statistically significant, $t(14.15)=-1.39$, $p=.19$ (equal variances not assumed).

² Visual inspection of the topographical maps suggests a broadly distributed effect for semantic congruency and an anterior effect for emotion congruency in the early window (350-500 ms) and a posterior effect for emotion congruency in the late time window (570-700 ms). As there were an unequal amount of electrode sites selected for anterior (21) versus posterior (16), statistical analyses were not computed.

Accuracy. To determine whether number of correct responses differed between groups, nine (Positive, negative neutral: S+, E+; Positive, negative, neutral: S-, E+; Positive, negative, neutral :S+, E-) independent samples t-tests were conducted and p values were adjusted using , Bonferoni correction. Response accuracy did not differ between groups for any of the conditions, all p-values $>.27$ (low AD: $M=37.38$, $SE=.39$; High AD: $M=36.61$, $SE=.55$). The mean accuracy of correct responses for the low AD group was 93.5%, and 91.5% for the high AD group.

Reaction times for Semantics (S+ E+ vs. S- E+)

Differences in reaction times across groups and experimental conditions were assessed using a repeated measures ANOVA for group x valence x congruency (S+E- vs. S-E+). A second ANOVA was used for the affective priming and congruency (S+E+ vs. S+E) x valence x group.

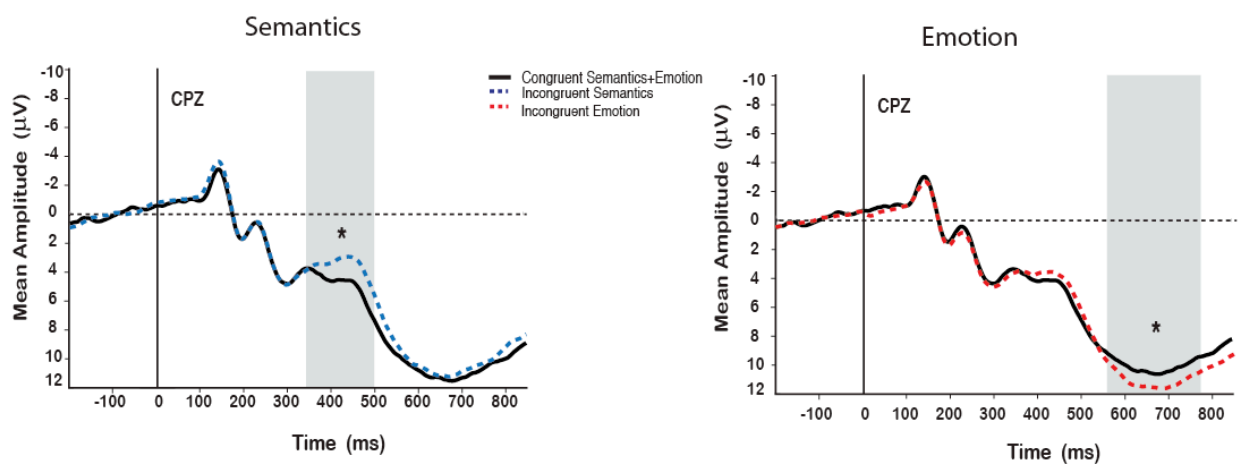
Reaction times between groups did not differ, $F(1,29)=1.70$, $p=.20$, $\eta^2 =.06$. Response times were faster for congruent ($M=1259.83$, $SE=88.71$) than incongruent trials ($M=1259.83$, $SE=86.51$), $F(1, 29)=4.66$, $p=.04$, $\eta^2 = .14$. Reaction times differed by valence, $F(2, 38.9)= 11.17$, $p=.001$, $\eta^2 =.28$. Bonferonni pair-wise comparisons revealed faster reaction times to both positive ($M=1174.31$, $SE=87.81$) and negatively ($M= 1218.18$, $SE=93.10$) valenced targets than to neutral targets ($M=1345.99$, $SE=89.20$).

Emotion (S+E+ vs. S+E-). Response times for both affectively congruent and incongruent targets did not differ, $F(1, 29)=.76$, $p=.39$, $\eta^2 =.03$. Groups did not differ significantly in their response times, $F(1, 29)=2.29$, $p=.14$, $\eta^2 = .07$. Reaction times differed for valence, $F(2, 38.54)=4.81$, $p=.03$, $\eta^2 = .14$. Reaction times for positive ($M=1195.28$, $SE=82.67$) and negative ($M=1269.38$, $SE=87.09$) targets were faster than neutral targets

($M=1328.81$, $SE=89.65$). However, Bonferroni pair-wise comparisons indicate only a near significant difference between positive and neutral targets, $p=.07$.

5.4.1 ERP results

ERPs and topographical maps for semantic and emotion congruency effects are illustrated in Figure 3. Congruency effects for semantic and emotion conditions are first reported separately for the groups combined. Interactions with group and valence are explored further in a subsequent section for groups separately using difference waves to subtract congruency effects.



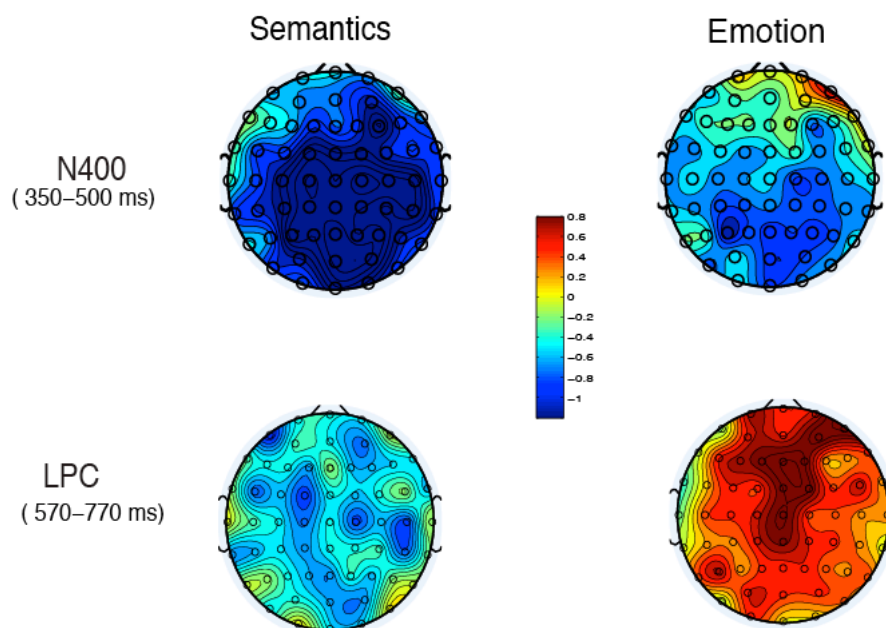


Figure 3. ERPs (top) and topographic maps (bottom) for semantic and emotion conditions showing an N400 for semantics and an LPC for emotion conditions for early and late time- windows.

Separate repeated measures ANOVAs are reported for semantic (S+ E+ vs. S-E+) and emotion (S+E+ vs .S+E-) conditions in the early and late time-windows, for anterior and posterior electrode sites. ANOVAs consisted of Group (high versus low for anxiety and depression on the HADS), x congruency (congruent versus incongruent) x valence (positive, neutral, negative), x electrode site. For all statistical analyses, the Greenhouse-Geisser correction was reported (Greenhouse & Geisser, 1959), when the assumption of sphericity was violated. ANOVAs for congruency effects are reported in Table 1, and for difference waves (incongruent-congruent) for positive, negative, and neutral valences for each group separately in Table 2.

Semantic congruency effect: (S+E+ vs. S-E+)

Early time-window (350-500ms). ERPs to the semantically incongruent targets elicited a larger negativity, N400, than to the congruent targets; main effect of congruency,

over both anterior and posterior sites (see Table 1). The size of the congruency effect differed by valence, valence x congruency interaction, at anterior sites; and valence x congruency x group at posterior regions. Pair-wise comparisons revealed that neutral ($M=2.03$, $SE=.68$) targets yielded a larger N400 congruency effect to semantically incongruent targets than did positive ($M=4.63$, $SE=.82$) and negatively valenced ($M=4.05$, $SE=.83$) targets.

Late time-window (570-770 ms). For the late time window there were no main effects of semantic congruency. However, there were significant group x semantic congruency x valence interactions over both anterior and posterior regions. These interactions will be examined below.

Emotion congruency effect (S+E+ vs. S+E-)

Early time-window (350-500ms). In the early time-window, there were no main effects or interactions with emotional congruency over anterior sites. In contrast, over posterior regions there was a significant N400 congruency effect for the emotion condition. The incongruent emotion word-pairs elicited a larger negativity compared to the congruent emotion word-pairs. There were no significant interactions with group or valence (see Table 1).

Late time-window (570-770 ms). For the late time-window, incongruent emotion targets yielded a larger positivity, (LPC) than congruent targets. The main effect of congruency was significant over posterior sites, but only approached significance over the anterior regions (see Table 1). A main effect of valence showed the LPC was larger to positively ($M=7.61$, $SE=.86$) and negatively ($M=7.71$, $SE=.87$) valenced targets, than to neutral targets ($M=6.48$, $SE=.79$), main effect of valence, $F(1.96, 56.86)=4.64$, $p=.01$, $\eta^2=.14$. Visual inspection of the ERPs over anterior regions revealed there was no emotional

congruency LPC effect for neutral targets, congruency effect for neutral targets $F(1,29) = .001, p = .97, \eta^2 = <.001$ nor posterior regions, $F(1,29) = .002, p = .97, \eta^2 = <.001$. In contrast, the LPC was larger to emotionally incongruent than congruent targets for both positively and negatively valenced targets, posterior, $F(1,29) = 5.78, p = .02, \eta^2 = .17$, but only approached significance at anterior regions, $F(1,29) = 3.88, p = .06, \eta^2 = .12$. However, the emotion congruency effect differed for the low and high AD groups between valence x group x congruency over anterior sites, and group x congruency over posterior regions (see Table 1).

Table 1. ANOVA table for congruency effects (congruent vs. incongruent)

<i>Effect</i>	Anterior sites			Posterior sites		
	<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2
Semantic (S+E+ vs. S-E+):						
<i>Early window (350-500)</i>						
Congruency	13.76	.001	.32	30.08	<.001	.51
Congruency x Valence	3.24	.05	.10	.88	.42	.03
Congruency x Valence x Group	2.90	.07	.09	4.05	.02	.12

Late window (570-770)

Congruency	1.72	.20	.05	1.60	.22	.05
Congruency x Valence	2.62	.08	.08	1.25	.29	.04
Congruency x Valence x Group	4.29	.02	.13	4.66	.01	.14

Emotion (S+E+ vs. S+E-):*Early window (350-500)*

Congruency	1.77	.19	.06	6.31	.02	.18
Congruency x valence	.35	.70	.01	.61	.55	.02
Congruency x valence x group	1.34	.27	.04	1.47	.24	.05

Late window (570-770)

Congruency	2.82	.10	.09	5.78	.02	.17
Congruency x Valence	1.07	.35	.04	1.81	.19	.06
Congruency x Group	.55	.46	.02	7.36	.01	.20
Congruency x valence x group	4.46	.02	.13	1.10	.30	.04

Semantics

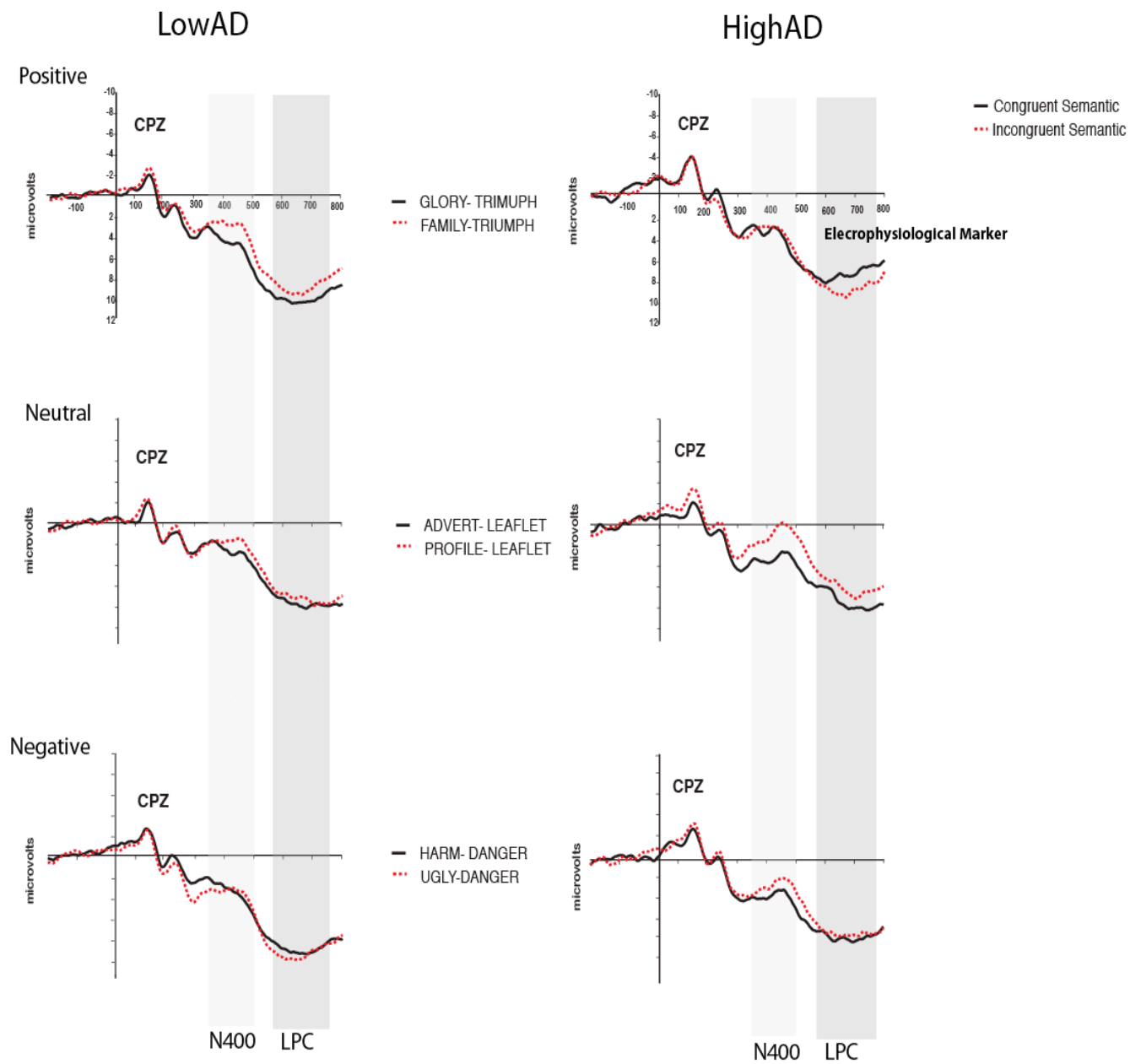


Figure 4. Grand- averaged waveforms for positive, negative and neutral valenced semantic congruency effects.

Emotion

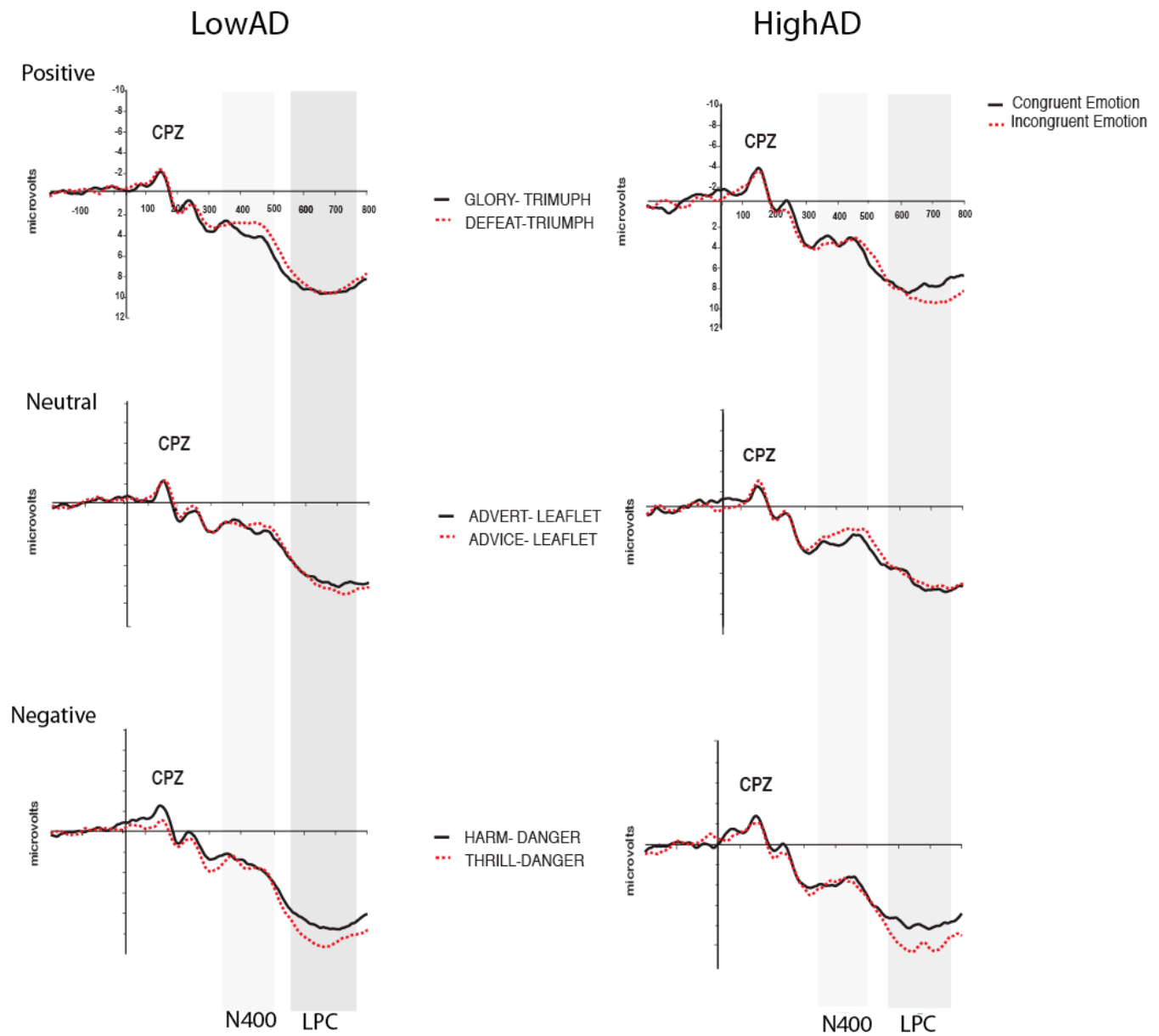


Figure 5. Grand- averaged waveforms for positive, negative and neutral affective congruency effects.

Table 2. ANOVA table for difference waves (congruent -incongruent) showing main effects of valence for Low and High AD groups

Low AD Group						
Effect of Valence	Anterior sites			Posterior sites		
Semantic (S+E+ vs. S-E+):	<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2
<i>Early window (350-500)</i>	.31	.70	.02	1.98	.16	.11
<i>Late window (570-770)</i>	.17	.82	.01	.88	.43	.05
Emotion (S+E+ vs. S+E-):						
<i>Early window (350-500)</i>	.19	.82	.01	1.67	.20	.10
<i>Late window (570-770)</i>	.52	.58	.03	2.11	.14	.12
High AD Group						
Effect of Valence	Anterior sites			Posterior sites		
Semantic (S+E+ vs. S-E+):	<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2
<i>Early window (350-500)</i>	4.10	.03	.24	2.66	.09	.17
<i>Late window (570-770)</i>	5.44	.01	.30	4.35	.03	.25
Emotion (S+E+ vs. S+E-):						
<i>Early window (350-500)</i>	1.39	.27	.10	.46	.64	.03
<i>Late window (570-770)</i>	6.49	.01	.33	4.51	.03	.26

5.4.2 Difference Waves for Low and High AD groups separately

To elucidate the interactions found between group x congruency x valence, difference waves (incongruent – congruent) were used to compare the magnitude of the N400 and LPC effects for each valence in the early and late time-windows. Repeated measures ANOVAs were run for each group separately, for valenced semantic difference waves (positive, negative, neutral) x electrode site; and valenced emotional difference waves x electrode site (Table 2). Paired t-tests with Bonferroni corrections were used to further explore valence differences. Analyses were run for anterior and posterior electrode sites separately.

Semantic Difference Waves (Incongruent - Congruent).

ERPs to semantically congruent and incongruent stimuli are illustrated for the Low and High AD groups separately (Figure 4).

Low AD

For the Low AD group, there were no significant effects of valence for the difference waves in the semantic condition, in either time window, or at any location.

High AD

Early time-window (350-500 ms). The amplitude of the N400 difference wave was larger to neutral (anterior, $M = -2.64$, $SE = .74$; posterior, $M = -2.57$, $SE = .69$) and negative (anterior, $M = -1.28$, $SE = .52$; posterior, $M = -1.58$, $SE = .49$) valence than to positively valenced stimuli (anterior, $M = .36$, $SE = .93$; posterior, $M = -.46$, $SE = .71$). Main effects of valence were significant over anterior sites and approached significance over posterior regions. Paired t-tests reveal the magnitude of the N400 was more negative for neutral compared to positive targets, $t(13) = 2.73$, $p = .02$, anterior; $t(13) = 2.25$, $p = .04$, posterior. Both

neutral and negative word-pairs elicited a larger amplitude of the N400, whereas positively valenced semantic difference waves did not elicit an N400³ (see Figure 4).

Late time-window (570-770 ms). There was a main effect of valence in the later time window over both anterior and posterior sites (Figure 4, Table 2). Both neutral and negative semantic difference waves elicited larger negativities than positively valenced semantic difference waves for anterior, $t(13)=3.29, p=.01$ and $t(13)=1.41, p=.07$ and posterior regions, $t(13)=2.17, p=.05, t(13)=2.70, p=.02$. Neutrally valenced semantic difference waves exhibited the greatest negativity (anterior, $M=-1.64, SE=.68$; posterior, $M=-1.22, SE=.76$) followed by negative word-pairs (anterior, $M=-.41, SE=.75$; posterior, $M=-.27, SE=.79$), whereas positively valenced semantic difference waves elicited a late positivity⁴, i.e., LPC, (anterior, $M=1.71, SE=.95$; posterior, $M=1.69, SE=.71$).

Emotion Difference Waves (Incongruent - Congruent).

ERPs to semantically congruent and incongruent stimuli are illustrated for the Low and High AD groups separately (Figure 5).

Low AD

For the Low AD group, there were no significant effects of valence for the difference waves in the emotion condition in either time window, or at any location.

High AD

Early time-window (350-500ms).

There were no effects of valence for the difference waves for the early time window

³ Semantic congruency effects (S+E+ vs. S-E+) x ES were only elicited for negative and neutral targets, The N400 congruency effects were strongest at posterior regions for both negative $F(1, 13)=10.37, p=.01, \eta^2=.44$; anterior $F(1, 13)=4.35, p=.06, \eta^2=.25$ and neutral targets $F(1, 13)=13.88, p<.01, \eta^2=.52$; anterior $F(1, 13)=11.51, p=.01, \eta^2=.47$. Positively valenced targets did not elicit semantic congruency effects at either anterior $F(1, 13)=.26, p=.62, \eta^2=.02$ or posterior regions, $F(1, 13)=.42, p=.53, \eta^2=.03$ (see figure 4).

⁴ In the late window, semantic incongruent versus semantic congruent word-pairs x ES elicited a positivity but only for positive semantically unrelated targets, $F(1, 13)=5.73, p=.03, \eta^2=.31$ at posterior regions. Neither negative nor neutral semantically unrelated targets elicited an LPC or N400 in the late time-window, for posterior sites, $F(1, 13)=.12, p=.73, \eta^2=.01$, or anterior sites $F(1, 13)=2.54, p=.14, \eta^2=.16$ (see figure 5).

over anterior or posterior sites (see Figure 5).

Late time-window (570-770 ms). The effect of valence was significant for both the anterior and posterior regions (see Table 2). Positive ($M= 1.86, SE=.89$) and negatively ($M=2.22, SE=.67$) valenced emotional difference waves elicited more positive amplitudes, larger LPC, compared to neutral word-pairs ($M=-.99, SE=.58$). Paired t-tests revealed no difference between positive and negatively valenced word-pairs, anterior, $t(13)=-.32, p=.75$; posterior, $t(13)= -.21, p=.84$. The amplitude of the LPC was more positive to positive (anterior $t(13)= 3.37, p=.01$; posterior, $t(13)=3.50, p<.01$) and negatively valenced targets (anterior, $t(13)=3.32, p=.01$; posterior, $t(13)=2.35, p=.04$) compared to neutral⁵.

Summary

Semantic congruency modulated the amplitude of the N400 across anterior and posterior regions. However, these effects interacted with group membership and emotional valence. For the low AD group, N400 semantic congruency effects were similar for positive, negative, and neutral stimuli. For the High AD group, only negative and neutral valences yielded an N400. Remarkably, positively valenced targets yielded an *LPC* for the semantic condition.

Emotional congruency modulated the LPC, over posterior and anterior regions. Similar to the N400, emotional congruency effects varied by group membership and valence. Surprisingly the low AD group did not display an LPC in the emotion condition for any valence. In contrast, the high AD group elicited an LPC emotion congruency effect for both positive and negative targets.

⁵ The LPC emotion congruency effect (S+E+ vs. S+E-) x ES was significant for positive and negative valenced targets, but not neutral valence, over posterior sites, $F(1, 13)= 7.53, p=.02, \eta^2=.37$, $F(1, 13)= 9.42, p=.01, \eta^2=.42$ and $F(1, 13)= 1.01, p=.33, \eta^2=.07$, respectively. For anterior sites, the emotional congruency was significant for negative $F(1, 13)= 9.42, p=.01, \eta^2=.42$, only approached significance for positive, $F(1, 13)= 4.36, p=.06, \eta^2=.25$, and was not significant for neutral $F(1, 13)= 3.34, p=.09, \eta^2=.20$.

5.5 Discussion

This is the first study to disentangle cognitive biases related to semantic and emotional effects in people with low versus high AD. Consistent with previous literature (e.g. Kanske & Kotz, 2007; Delaney-Busch & Kuperberg, 2013), an N400 congruency effect was elicited by semantic incongruency between word-pairs, whereas a later emotional evaluation effect, an LPC, was elicited for affectively incongruent word-pairs when data from both groups were considered together. However, previous studies did not measure psychiatric traits, which we found interacted with valence and modulated the amplitude of both the N400 and the LPC. Inconsistencies in the literature have been found for the LPC, with some studies finding an LPC for positively valenced words compared to neutral or negative (Kissler, Herbert, Winkler & Junghofer, 2009), an LPC for only negatively valenced words (Kanske & Kotz, 2007) or no LPC at all (Leon et al., 2010). The inconsistencies in the literature could be attributed to not measuring psychiatric traits such as anxiety and depression. Our participants were drawn from a similar population to other studies- i.e. a University student participation panel- and elicited comparable effects to previous studies when groups were combined. However, when considering groups separately due to interactions with valence and conditions, the low AD group do not have an LPC emotion congruency effect, whereas the high AD group do.

Similarly, for semantic incongruency the low and high AD groups showed different patterns, with the low AD group displaying a similar magnitude of N400 effect for each valence, compared to the high AD group. For the high AD group, we predicted that semantic integration would be facilitated (smaller N400) for negative semantically unrelated word-pairs, as low mood is congruent with negative meaning (Chwilla et al., 2011). Contrary to our prediction, both negative and neutral semantically unrelated word-pairs elicited N400 congruency effects of a similar amplitude. Both the low and high AD groups elicited similar

amplitudes of N400 congruency effects for negative and neutral semantically unrelated word-pairs, suggesting groups had similar processing styles for negative and neutral unrelated semantics. Although groups differed on negative mood, indexed by scores for negative affect on the PANAS, this difference did not reach significance and did not effect semantic integration. Since semantic integration for the high AD group was similar for both neutral and negative semantic congruency effects, enhanced processing for negative stimuli was not supported (negative potentiation hypothesis, Beck, Rush, Shaw & Emery, 1979; Beck, 2008). However, the high AD group displayed attenuated semantic integration for positive stimuli, along with a later emotional effect, in line with the positive attenuation hypothesis (Clark et al., 1994). Previous ERP studies (Iakimova et al., 2009; Deldin et al., 2006) found normal semantic integration in patients with depression. However, those studies only examined semantic violations in neutral contexts. In contrast, the present study examined both valenced semantic and affective congruency, and found group differences with semantic integration of positive unrelated meaning, and differences with later emotional effects. We will discuss these interpretations in turn.

5.5.1 Positive semantic integration

Consistent with the previous literature, the low AD group displayed an N400 semantic congruency effect for neutral, negative and positive valences. In contrast, the high AD group did not display an N400 for semantic incongruencies for positively valenced word pairs. Surprisingly they showed an LPC to semantic violations. One possible explanation is that for positive words, meaningful relations are being processed using brain systems usually involved in emotional processing.

Later processing for positive unrelated semantics, and lack of an N400 congruency effect, indicates that the high AD group might find positive information more difficult to integrate semantically. Positive semantics could be difficult to integrate, as anxiety and

depression are associated with cognitive biases, low affect, and negative schemas, that are inconsistent with positive meaning (Giesler, Josephs, & Swann, 1996). Although our sample did not examine clinical patients per se as we sourced our participants from a student sample, high scores on the HADS (assessing anxiety/ depression) have been reliable predictors for cases of anxiety and depression (Herrero et al., 2003; Abiodun, 1994; Wilkinson & Barczak, 1988). Furthermore, our high AD group had lower positive affect than the low AD group, as measured on the PANAS. Qualitative differences between groups in the way the brain processes positive affect could be symptomatic of anxiety/ depression. We propose that the diminished N400 and later LPC for positive meaning could serve as an electrophysiological marker of low positive affect and cognitive bias in anxiety/depression. Since low positive affect is related to cognitive biases, and symptom maintenance (Macleod & Byrne, 1996; Nolen-Hoeksema, Wisco & Blair, 2008), the lack of an N400 for positive meaning could serve as a neural marker for cases of anxiety and depression.

5.5.2 Affective Primacy & Neural differences

For the high AD group, the lack of N400 but later emotion evaluation, LPC, for positive unrelated semantics, indicates the high AD group could be processing positive semantics emotionally. That is, for positive words meaningful relations are processed by the neural systems typically involved in processing emotional information. The affective primacy hypothesis (Zajonc, 1980; 1984) postulates earlier cognitive processes can be bypassed due to motivational significance and arousal of emotional stimuli. Therefore, the high AD group could be bypassing semantic integration (no N400) due to a greater level of autonomic arousal and later evaluation of positive valence (LPC).

Our findings indicate that both the low AD and high AD groups process positive unrelated semantics differentially. The low AD group elicits an N400 congruency effect for positive unrelated semantics, whereas the high AD group elicits an LPC. As both groups

process positive semantics differentially from each other, it is likely that different processing strategies are used for positive meaning. Neuroimaging studies have demonstrated that interpreting positive meaning for people with depression is associated with decreased amygdala activation compared to controls (Canli et al., 2004; Sass et al., 2012). As the low AD group elicits an N400 for positive meaning and the high AD group elicits an LPC, it is likely that each group uses different neural populations to process positive meaning. Both the N400 and the LPC have been associated with different neural generators (see Halgren et al., 2002 for N400 and Sabatinelli et al., 2007 for LPC). The neural generators for the N400 are thought to be broadly distributed and include inferior and dorsolateral prefrontal cortices, anterior temporal and orbital cortices, amongst others (See Hagoort et al., 2004; Halgren et al., 2002). Conversely, the neural generators of the LPC have been linked to posterior and occipital cortices for emotional versus neutral picture stimuli (see Keil et al., 2002; Sabatinelli, Lang, Keil & Bradley, 2007). Based on the differential neural systems associated with semantic and emotional processing, and differential neural responses for positive semantics (N400 vs. LPC) for each group, it is likely groups are processing positive meaning in a qualitatively different way, using different neural systems.

5.5.3 Emotional processing

The high and low AD groups processed affective stimuli (congruent versus incongruent emotion) differentially. For the low AD group, an LPC effect was not elicited for positive or negative emotionally incongruent stimuli. However, the high AD group elicited an LPC of similar amplitudes for both positive and negative emotionally incongruent word-pairs. This is the first study to demonstrate that people with high trait anxiety/depression elicit LPC, emotional effects for both positive and negative affective stimuli. One possibility for this novel finding is in the paradigms previously used. Other electrophysiological studies have used oddball designs (e.g. Ilardi et al, 2008), conflict

monitoring tasks (Kanske & Kotz, 2013) or did not examine the LPC (Klumpp et al., 2010). Consequently, later emotion evaluation effects, i.e., following the N400 time window, have not previously been reported. Similar LPC amplitudes for positive and negative emotional word-pairs suggest people with high trait anxiety/depression are able to evaluate and sustain processing for affective stimuli. Specifically, the high AD group could have a higher degree of sensitivity to emotional stimuli (e.g. emotionality hypothesis; Martin, Williams & Clark, 1991) than the Low AD group. Consistent with this interpretation, Bradley et al., (1999) reported enhanced vigilance for positive and negative emotion pictures, in people with generalized anxiety disorder. Our results extend and compliment some of Rottenberg et al., (2005)'s galvanic skin response findings, namely both positive and negative emotional effects elicited similar responses for the high AD group.

In contrast to previous studies reporting an LPC for positive (Kissler, Herbert, Winkler & Junghofer, 2009), negative (Kanske & Kotz, 2007), and even neutral stimuli (Hinojosa et al., 2009), the low AD group in the present study did not show an LPC affective congruency effect. Although we have elicited an LPC for emotional incongruency, it was only for the high AD group. A possible reason for the discrepant findings for emotion congruency effects between studies could be levels of trait anxiety and depression. Neither Leon et al., (2010) nor Herbert et al., (2008) explicitly examined trait level of anxiety and depression, which we have illustrated interacts with emotional valence and congruency effects. Nevertheless, Moreno and Vasquez (2011) did examine depressive symptoms, and reported that their sample was within a normal range, though, they did not find a robust LPC effect for emotion incongruency. Consistent with these other studies, the majority of our participants were selected from the University student participation panel, and in this sample we found high levels of trait anxiety and depression. There could be three other reasons that the emotional incongruency effects did not elicit an LPC for the low AD group. Firstly,

emotional stimuli could have a reduced level of autonomic arousal and motivational significance for the low AD compared to the high AD group. Indeed the amplitude of the LPC is sensitive to both motivational significance (e.g. Gable & Harmon-Jones, 2013) and emotional arousal (e.g. Carretie et al., 2008). Therefore the lack of an LPC effect could indicate the emotional stimuli used may not have been emotionally arousing to the low AD group. Secondly, inter-individual differences can modulate the amplitude of the LPC (Kos, van den Brink & Hagoort, 2012), so this variability in the low AD group could be influencing the null effect of the LPC. Finally, low power could have driven the null effect. However, the number of participants in the low AD group (n=17) is similar to previous studies such as Herbert et al., (2008) who tested 16 participants, used a similar word paradigm and found a LPC for positive valence.

The main focus of this investigation was how people with low versus high trait anxiety/ depression interpret valenced semantic and emotional word-pairs. We have demonstrated that levels of anxiety and depression cause differential processing of positively valenced semantic word-pairs and affective information. Furthermore, we have been able to separate the combined effects of semantics and emotion for the high AD group, and can conclude it is positive meaning that is affected in anxiety/ depression not difficulty differentiating between positive and negative emotional stimuli per se. The low AD group was not sensitive to the emotional valence of stimuli, as semantics elicited an N400 effect of comparable amplitude across valence. However the N400 congruency effects for semantics and lack of emotional congruency effects suggest the low AD group were sensitive to integrating stimuli with preceding context and did not find the stimuli as emotionally arousing (e.g. Schupp et al., 2004a). As previous studies did not explicitly control for levels of trait anxiety and depression, the LPC elicited may be related to levels of trait anxiety and depression.

Implications & Conclusions

For the high AD group, the later emotional LPC effect for positive semantics could serve as an electrophysiological marker related to difficulty with positive meaning. As cognitive behaviour therapy promotes modifying thought patterns to enable better problem-solving skills (e.g. Brewin, 2006), a typical N400 response to positive meaning could be elicited after treatment. This study has important clinical implications, with difficulty interpreting positive meaning associated with trait depression/ anxiety. Future studies could examine positive semantic integration in patients with major depressive disorder and generalized anxiety disorder before and after treatment, to see whether semantic integration for positive valence yields an N400 after treatment.

CHAPTER 6: General Discussion

The objective of this thesis was to examine the interface between emotion and cognition, namely how cognitive processes such as memory recall (Chapter 4), meaning and emotive language (Chapters 2 and 5) are modulated by emotion. In addition, we examined the relationship between cultural affinity and age and order of language acquisition to assess whether cultural affinity modulates the strength of emotional associations even in early highly-proficient bilinguals (Chapter 3). Unlike previous studies exploring the interaction between cultural context and language, we explicitly controlled the emotional concepts included in our study (see Chapter 2). In line with psychological constructivist perspectives (e.g. Barrett et al., 2007), I defined emotion as physiological arousal combined with cognitive appraisal.

The findings in this thesis were consistent with psychological constructivist, evolutionary and embodied models of cognition. Chapters 3 + 4 were consistent with psychological constructivist accounts of emotion, in that context, namely cultural associations and context of acquisition modulated cultural identity associations and memory recall. The findings for emotional arousal between L1 and L2 in Chapter 4 were consistent with evolutionary accounts of emotion. Emotional arousal did not differ between L1 and L2, regardless of age of acquisition or proficiency, indicating that emotional arousal is modulated to a similar extent, regardless of context. Finally, our ERP study, in chapter 4 indicated that psychiatric variables interacted with semantic and emotional processing, supporting embodied models of cognition and evolutionary accounts, as well as highlighting the need to assess these variables in future ERP studies. This chapter will explain the

findings from Chapters 3, 4 and 5 in greater depth, as well as interpreting these findings within the broader theoretical literature.

6.0 Assessing emotion and cognition: measures used

The relationship between emotion and cognition was explored using both behavioural (implicit association tasks, memory recall) and electrophysiological methods. Using different methodologies allowed us to explore the relationship between emotion and cognition at the behavioural and neural level, which provides greater validity and insight into the cognition and emotion debate (e.g. the primacy of affect, Zajonc, 1980 versus primacy of cognition, Lazarus, 1991). Previous studies exploring the emotion and cognition debate used only behavioural (e.g. Murphy & Zajonc, 1993; Lazarus, 1991) or neuroimaging (e.g. LeDoux, 2000) methods to substantiate their research hypothesis/ theory. However, some of the most extensive work on the relationship between emotion and cognition has been undertaken using a variety of physiological, behavioural and electrophysiological measures (Löw, Lang, Smith & Bradley, 2008; Herbert, Kissler, Junghofer, Peyk & Rockstroh, 2006; Schupp et al., 2004). The strength of triangulating data through a variety of different methodologies enabled us to elucidate the interface between cognition and emotion more extensively, as different task demands such as implicit evaluation versus explicit evaluation could be modulated by different neural circuitry (e.g. Storbeck, Robinson & McCourt, 2006). For example, more explicit controlled evaluations are posited as governed by top-down regulation from the ventrolateral prefrontal cortex (vIPFC) and anterior cingulate cortex (ACC). Activation of these areas has been related to inhibition of inappropriate response (vIPFC; Cunningham et al., 2004) and emotional regulation (ACC; Stevens, Hurley & Taber, 2011). Through accounting for subjective emotion responses (explicit emotion tasks: autobiographical memory study; explicit cultural identity; emotion evaluation) and implicit emotional associations (implicit association task; valenced semantic word –pairs in the ERP

study), we can address more implicit direct emotional processes and more protracted emotional processes. Thus these studies enabled us to expand upon the relationship between cognition and emotion.

In line with psychological constructivists such as Barrett (2011, 2013) and Gendron et al., (2012), the studies in this thesis support the assertion that emotion and cognition are interlinked, and emotional experiences are constructed based on contextual and experiential factors such as linguistic input, language (Chapters 3 & 4), mood (Chapter 5) and context of linguistic experience (Chapters 3 & 4). I will discuss these interpretations related to each chapter in turn.

6.1 Cultural context and age of acquisition affects emotion evaluations

In Chapter 3, we examined the interaction between emotion and cognition using implicit and explicit measures of cultural affinity. Furthermore, we explored whether cultural context and age and order of language acquisition could impact implicit versus explicit cultural identity in early highly proficient bilinguals. In order to explore this question, we examined Welsh-English bilinguals who learned their first and second language at the same time. However, order of language acquisition differed between groups, i.e. L1 Welsh bilinguals learned Welsh first and subsequently learned English at age 5-8; whereas L2 Welsh bilinguals learned English first and Welsh between the ages of 5-8. We also tested a group of simultaneous Welsh-English bilinguals who served as a control group. Because implicit biases have been related to fast, automatic associations formed early in childhood (Baron & Banaji, 2006; Dunham, Chen & Banaji, 2013), we predicted order of language acquisition could modulate the strength of implicit cultural biases. Furthermore implicit and explicit biases have been related to different developmental trajectories (Frith & Frith, 2008), thus we predicted dissociation between implicit and explicit cultural biases, based on age and order of language acquisition.

Following our predictions, implicit and explicit cultural identity biases were dissociated, with opposite biases related to implicit and explicit identity. The L1 Welsh group exhibited the largest implicit cultural identity bias followed by simultaneous then L2 Welsh bilinguals. In contrast for explicit identity, the L2 Welsh bilinguals exhibited the greatest Welsh bias, followed by the simultaneous and then the L1 Welsh bilinguals who reported the smallest explicit Welsh bias. These results are consistent with the different developmental trajectories associated with implicit and explicit biases (e.g. Frith & Frith, 2008). Similar to literature exploring racial biases in adults and children (Baron & Banaji, 2006; Dunham, Chen & Banaji, 2013), implicit biases were affected by age and order of language acquisition even in early highly proficient bilinguals, matched for socio-economic status. Expanding on previous literature, our study elucidated that the implicit cultural bias was long lasting even into adulthood. Similarly, the explicit bias was consistent with the cultural norms and values a primarily Welsh speaking society in Caernarfon, Gwynedd and Anglesey from where our participants were primarily recruited (85.6%, ~65% and ~74% respectively: Office for National Statistics, 2001; 2011).

6.2 Cultural context and psychological constructivism

The theory of psychological constructivism (Barrett, 2011; 2013) could provide support for these findings in the wider emotional literature since context of acquisition modulated the relationship between emotion and cognition. Psychological constructivism (Barrett, 2011; 2013) postulates that the visceral elements of emotion, i.e. fluctuations in mood, hormones and bodily-changes (core affect) can be paired with learned and contextual associations in an environment. For example, fear could be construed as a form of learned associations of which context modulates these responses. In a review article, Phelps (2010) reported enhanced amygdala activation for learned fear responses, indicating context of association and conditioning of a fear response is mediated by amygdala activation.

Similarly, Bishop et al., (2004) examined participants who were low or high on state anxiety, and found similar level of amygdala activation for high anxious participants for benign (neutral) and threatening (fear faces) stimuli, which could suggest aberrant conditioning of non-threatening stimuli. Some anxiety models have postulated that fear is exacerbated through benign stimuli gaining a conditioned fear-response (see Bishop, 2007 for a review). A different fear response is elicited when watching a horror movie compared to someone following you down a dark street, or going on a rollercoaster. A person may or may not be conscious of the referent of their fear-response, nonetheless, the context in which these responses occur are important. For example, social norms mediate how we act in public; even if someone is angry, typically that emotion is regulated, as it would be inappropriate to attack another person. Thus, the strength of emotional associations can be modulated in different context. If a language context modulates affinity, it is likely participants would respond quicker to emotional terms related to cultural bias- congruent with cultural experience. Our findings support this assertion- stronger implicit cultural bias for L1 Welsh> simultaneous> L2 Welsh, based upon context and order of acquisition.

6.3 Word control, limitations & future studies

Previous IAT papers associated with language and culture (e.g. Danziger & Ward, 2010; Ogunnaiké et al., 2010) did not control for word parameters such as valence, arousal, length or frequency between languages. This is specifically important for bilingual research, since valence and arousal of emotion words can bias strength of emotional reactions or associations (e.g. Ferre et al., 2010). We were the first to explicitly control for these word parameters between languages. In Chapter 2 we matched emotional attributes in both Welsh and English versions of the IAT, so the strength of implicit bias cannot be a function of different levels of emotional arousal intrinsic with different languages. The importance of

controlling these parameters has largely been neglected in the bilingual IAT literature at large.

A limitation of this study is that emotional processing was not directly manipulated, however, implicit emotional processing is associated with the strength of the biases (e.g. Cunningham et al., 2004). Future studies could examine the relative strength of implicit bias after positive, negative and neutral mood induction in each language. In addition, the relationship between implicit and explicit biases could be differentially linked to emotional processing, with implicit biases being more automatic emotion generation whereas explicit biases could be more susceptible to cognitive interference.

6.4 Autobiographical memory recall, emotion and cognition

Autobiographical memory studies, to some extent, could bridge the gap between automatic emotional processes and controlled evaluation, as autobiographical memory recall involves automatic memory generation but the context is confined by the valenced cue word presented. Thus, we explored the relationship and interaction between cognition and emotional memory using an autobiographical memory test, for first versus second languages of a bilingual.

In Chapter 4- the autobiographical memory study, we explored whether memory structure is differentially associated with language context and acquisition in L1/ L2, which could help elucidate how context of linguistic input modulates emotional construction. Furthermore, levels of emotional arousal were explored between L1 and L2 to determine whether context modulates emotional arousal, or whether a more automatic evolutionary response was elicited.

6.5 Autobiographical memory structure: psychological constructivism

The structure of autobiographical memories (specific>general>timeline) did not differ between the first and second languages for L1 Welsh and simultaneous bilinguals. However L2 Welsh bilinguals recalled more specific memories in Welsh (L2) for negative cue words, and more timeline memories were recalled for positive cue words. The L2 Welsh group was the only group in which there was a large discrepancy in proficiency between L1 and L2, although they were still being highly proficient, early bilinguals.

In line with models of psychological constructivism such as the ‘conceptual act model’ (Barrett, 2011), experiential factors such as language learning context, frequency and proficiency could explain the valence x memory type interaction for the L2 Welsh bilinguals. The early L1 Welsh group learned Welsh at home, with both parents being fluent, the simultaneous bilinguals had a parent speaking each language whereas the L2 Welsh group typically had 2 English-speaking parents and only speaking Welsh in an instructed setting-school. Although, L1 Welsh bilinguals also learned English (L2) in an instructed setting, their levels of proficiency showed a smaller discrepancy between L1 and L2, suggesting greater experience or exposure to English- which is consistent with the linguistic climate in Wales (Gathercole & Thomas, 2009). Indeed, command of Welsh has been correlated to linguistic input received at home and at school, whereas command of English does not differ, regardless of learning context (Gathercole & Thomas, 2009). The context of language acquisition and frequency of language use was therefore different between groups and could have accounted for the valence x memory type interaction for the L2 Welsh group. In addition, higher scores on Welsh proficiency was a significant predictor for specific memory types associated with positive cue words, for all groups. However, only the L2 Welsh group displayed an interaction with valence x memory type, suggesting the discrepancy between proficiency in L1 and L2 could be driving the effect.

Although early bilinguals, the L2 Welsh bilinguals used Welsh less frequently but had a stronger explicit Welsh cultural affinity (see Chapter 3; cultural identity), which could account for the greater proportion of timeline memories retrieved for positive cue words in Welsh. Greater cultural affinity with a language has been related to augmented skin conductance responses, regardless of age of acquisition (e.g. Caldwell-Harris et al., 2011; Simcox, Pilotti, Mahamane & Romero, 2012). Additionally, frequency of language use facilitated skin conductance responses regardless of age of acquisition (Simcox et al., 2012). Context of language learning has been related to more emotional distance in L2 compared to L1 (Dewaele & Nakano, 2013), which could be related to strength of associations afforded to a more confined social interaction in an instructed setting. Thus, the greater proportion of positive timeline memories retrieved for L2 Welsh bilinguals could reflect the context of acquisition and differential emotional experience in L1 versus L2. On the whole, the autobiographical memory responses support the theory of situated or constructed emotion, based upon context of emotional experiences (e.g. Barsalou, 2009; Barrett, et al., 2007).

6.6 Emotional arousal: evolutionary emotion models

We also examined the strength of emotional arousal for memories in L1 versus L2 for early, highly proficient bilinguals who were matched for age of acquisition for L1 and L2, but differed on order of acquisition. Our rationale was based upon discrepant findings in previous emotion studies. Some studies have reported heightened emotional arousal in L1 compared to L2 based on earlier age of acquisition (Winkel, 2013; Harris, 2004) and higher proficiency (Caldwell-Harris, Tong, Lung & Poo, 2011). Others have reported similar magnitude of emotional arousal in L1 and L2, regardless of age of acquisition and proficiency (e.g. Ferre et al., 2010; Eilola et al., 2007). Thus, we examined whether contextual factors such as age of acquisition and proficiency modulate emotional arousal

consistent with psychological constructivism (e.g. Barrett, 2013); or whether emotional arousal is similar between languages, consistent with evolutionary models of emotion (e.g. Bradley et al., 2001)

Emotional arousal was similar between L1 and L2 for all groups, suggesting the strength of emotional arousal provided for each language was of similar magnitude. In contrast to memory type x valence interaction, the similarity for arousal between L1 and L2 would indicate that arousal elicited for each language is not as sensitive to contextual features. Importantly, proficiency differences between L1 and L2 did not modulate the strength of emotional arousal for any group. Emotional arousal was heightened for negative cue words in both first and second languages, suggesting a negative bias, regardless of context of acquisition, linguistic input and proficiency. This finding is in line with evolutionary models of emotion such as Panksepp (2003, 2004) or Bradley et al., (2001), as regardless of language, emotional intensity was greater for negative cue words, which suggests activation of aversive motivational system. It has been hypothesized that the aversive system is susceptible to threat, danger –with more negative experiences being recalled more vividly (Bernston, 2002; Kensinger & Corkin, 2003). The function of autobiographical memories has been linked to problem-solving, social bonding and ability to adapt/ respond to future situations (Bluck, Alea, Habermans & Rubin, 2005). Our findings are consistent with this assertion, even for the L2 valence x memory type interaction- as it would facilitate an individual in further social interaction if they are able to draw on specific events associated with negative experiences. In evolutionary emotion models such as Bradley et al., (2001), autonomic arousal has been related to ERP components such as the LPC, which are modulated by the emotional arousal and valence of a word (Herbert, Kissler, Junghofer, Peyk & Rockstroh, 2006) or picture (Schupp et al., 2000). However, we did not assess autonomic arousal, but rather a post-hoc rating of the strength of emotional arousal

related to memories in L1 and L2. Thus, in this task, memory retrieval could have been more susceptible to more elaborated cognitive processes, similar to explicit race bias task (e.g. Cunningham et al., 2004; Phelps et al., 2000). In addition, although the degree of inter-rater reliability between the two raters was high (.79 for Welsh and .81 for English arousal), we are tapping into subjective ratings of emotional intensity, not automatic. Nevertheless, the lack of differences in emotional intensity between L1/ L2 could reflect ease of conveying emotional memories similarly in either language of early highly proficient bilinguals.

6.7 Limitations & future studies

One limitation of the study was not assessing which language the memory was retrieved, which would have enabled us to make more direct comparisons with language and emotional interactions. Future studies could encompass an autonomic elicitation of emotional arousal to see whether emotional intensity for L1/ L2 differed at the autonomic level. Later age of acquisition -i.e. after 12- is associated with structural and functional brain changes for syntactic processing (Johnson & Newport, 1989) and proficiency (Flege et al., 2006). Furthermore, context and linguistic experience would differ further for early versus late bilinguals, thus a follow-up fMRI study could explore whether early vs. later age of acquisition would modulate structure of autobiographical memories and differences in arousal levels.

For both the IAT and autobiographical memory studies (Chapters 3 and 4) we explored the interactions between emotion and cognition using cultural context (IAT) and memory recall, in behavioural implicit and explicit tasks. However, to further elucidate the relationship between emotion and cognition, we examined semantic and emotional processing at the neural level using event-related potentials. For the ERP study (Chapter 5), we examined emotion and cognition in monolinguals who varied in levels of trait anxiety

and depression. This study also provided some insight into the relationship between psychiatric illnesses and meaning/ emotional processing.

6.8 Emotion & cognition: levels of trait anxiety/ depression in monolinguals- ERPs

In line with previous studies (Delaney-Busch & Kuperberg, 2013; Herbert et al., 2008) we examined how monolinguals processed emotionally and semantically valenced words using both semantic and affective priming. However, we included an additional step in our study, namely we examined how people with different levels of trait anxiety and depression processed semantic and emotional word-pairs. This adds an additional dimension to previous studies, as we are exploring the interaction between emotion and cognition in people with different levels of trait anxiety/depression, through an ERP component related to semantic context, the N400 (Kutas & Hillyard, 1984), and an ERP component related to emotional processing- the LPC (Kissler et al., 2006). No previous study has examined explicitly how levels of trait anxiety and depression can modulate semantic and emotional processes (e.g. Delaney-Busch & Kuperberg, 2013; Herbert et al., 2008). However, our results are comparable to other studies examining semantic and emotion integration, as we recruited our participants from a similar subject pool as these studies - a University participation panel (Delaney-Busch & Kuperberg, 2013; Herbert et al., 2008).

Anxiety and depression have been related to cognitive biases such as a negativity bias for depression (Beck, 2008), and threat-biases for anxiety (Beck & Clark, 1997; Li et al., 2008), which indicate heightened attentional allocation to negative or fear-related words/ pictures (Siegle et al., 2002; Bishop et al., 2004). In addition, ineffective emotional regulation has been found for both disorders - that is attenuated activity in areas such as the striatum (reward processing) compared to controls (Heller et al., 2009), and hypoactivation in prefrontal areas associated with emotional regulation (Fitzgerald et al., 2008; Drevets, 2001). However, whether the maintenance of the disorders is related to emotional difficulty

caused by difficulty processing positive meaning (reduced emotional regulation) or heightened processing of negative meaning (negative bias) remain entangled. Our study enabled us to disentangle the biases related to anxiety/ depression as well as explore the relationship between cognition and emotion in monolingual controls.

6.9 Semantic/ Emotional priming

Semantic and emotional context can be established through a preceding context-known as priming (Holcomb, 1993). In electrophysiological studies, semantic priming elicits a large negativity, N400, to an incongruent concept when compared to a congruent context (Holcomb & Neville, 1990). Similarly, after establishing an emotional context (e.g. neutral words) when word does not fit into that same context or when heightened attentional allocation is given to the emotional word, an LPC, large positivity to incongruent context is elicited (see Citron, 2012; Kissler et al., 2006).

In Chapter 5, we used a priming paradigm, which enabled us to prime emotional context for positive, negative and neutral target words, whilst simultaneously controlling for semantic context. For the emotion condition, primes were selected that were semantically consistent with the target but emotionally inconsistent (S+, E-). Similarly, for the semantic condition we primed semantic context with primes related to the target emotionally but were incongruent for semantics (E+, S-). In addition, we had a baseline condition whereby word-pairs were consistent both semantically and emotionally (S+E+). In accordance with previous ERP priming literature (Chwilla et al., 2011; Delaney-Busch & Kuperberg, 2013), we time-locked the semantic and emotion conditions to the target. Incongruent semantic (S-E+) and incongruent emotion (S+E-) conditions were compared against the congruent condition baseline (S+E+), which served to establish semantic and emotional context.

6.10 Semantic/ Emotion effects: Low AD- Embodied Cognition?

The low AD displayed an N400 for semantically unrelated word-pairs for positive, negative and neutral valence, comparable to previous literature (Leon et al., 2010; Moreno & Vasquez, 2011; Herbert et al., 2008). These results are discrepant with models of embodied cognition to some extent (e.g. Niedenthal, 2007). If, as suggested by embodied cognition, facial expression such as smiling facilitates processing of positive meaning (e.g. see Havas et al., 2007; Niedenthal, 2007), we would expect the low AD group, who scored higher on positive affect (PANAS scores) to have a smaller N400 congruency effect to positively valenced semantics, as they were in a more positive mood than the high AD group. However, the low AD group has comparable N400 amplitude -congruency effects across each valence for semantics. Previous studies whose findings support embodied cognition have typically induced mood through various means-such as happy/ sad clips (Moreno & Vasquez, 2011; Egidi & Nusbaum, 2012), or contraction of the corrugator/ zygomaticus major muscles (Havas et al., 2007; Niedenthal, 2007), which have facilitated processing of positive stimuli in positive mood and vice versa for negative mood. The mood state of the low AD group in our study was significantly higher for positive compared to negative affect, which is similar to mood states reported in mood induction studies. Discrepant findings related to mood could be related to contextual effects associated with mood being artificially induced via movie clips similar to priming; whereas our study assessed participants in a day-to-day mood. Therefore, an interesting question relating to previous studies and the similarity for low AD group in the N400 response, could be whether information processing could be subject to differences in neural responses in artificially induced compared to normal mood.

6.11 N400 inhibition or integration effect?

Nevertheless, a mood induction study such as Chwilla et al., (2011) found a larger N400 response for positive sentences even when participants were in a positive mood, indicating augmented semantic integration- similar to our study. Positive mood is related to better problem solving (Nolen-Hoeksema et al., 2008; Fredrickson, 1998) and broader information processing (Fredrickson & Branigan, 2005), which would suggest facilitated semantic integration - reduced N400 congruency effects. However, both Chwilla et al., (2011) and our study would support the inhibition account of the N400 (Debruille, 1998; 2007). Typically the N400 is related to semantic integration of information into a context- the semantic integration account of the N400 (Kutas & Federmeier, 2000; 2011). However, Debruille (1998; 2007) postulated that the N400 could be consistent with an inhibition effect, which indicates the suppression of competing activations, which typically renders a larger N400 (Debruille, 2007). The inhibition of competing activations of semantic competitors would yield larger N400 effects for positive valence, and is consistent with a broader search in positive mood. Another interpretation of the N400 results for the low AD group could be that valence of stimuli was not subject to sensitive contextual constraints. This interpretation is consistent with the lack of an LPC for positive and negative valence compared to neutral for the low AD group.

Although the lack of LPC for the low AD group in our study is seemingly inconsistent with previous ERP studies (e.g. Delaney-Busch & Kuperberg, 2013; Herbert et al., 2008; Leon et al., 2010), these studies have not explicitly controlled or measured levels of anxiety and depression. When our groups were combined, our results replicate previous findings - that is an N400 effect for valenced semantics, and an LPC to positive and negative emotion congruency effects (Delaney-Busch & Kuperberg, 2013; Herbert et al., 2008; Kanske & Kotz, 2007). However, these results were subject to interactions between group

(low/high AD) x valence x congruency, indicating levels of anxiety/depression can modulate congruency effects for both semantics and emotion.

6.12 Semantic/ Emotion effects: High AD- Embodied Cognition

The high AD group elicited larger N400 semantic congruency effects for negative and neutral valenced word-pairs. Embodied cognition models (Havas et al., 2007; Niedenthal, 2007) would predict facilitated information processing (smaller N400 effect) for negative valence, but our results are not consistent with that proposition, as the high AD group have a larger N400 response to negatively valenced semantic incongruencies. Negative mood has been related to difficulty with problem-solving (Nolen-Hoeksema et al., 2008), therefore comparable processing for neutral and negative valenced meaning could indicate mood does not affect information processing, or similar to my discussion point for the low AD group above (see section 6.11)- the N400 inhibition model could be consistent with this findings (Debrulle, 1998; 2007). Debrulle (2007) proposes that more semantic activations are present which are being inhibited therefore the N400 is a measure of inhibiting irrelevant associations. This account would be consistent for this group, as more negative associations could be elicited for people with high AD, therefore a greater need to suppress/ inhibit these associations would cause a larger N400. This interpretation is consistent with the low AD group's N400 response- similar magnitude of N400 for all valenced stimuli.

6.13 The positive paradox

In contrast, for the high AD group, positive valence was subject to no N400 congruency effect, but an LPC for integration of positive valence - I suggest this is an electrophysiological marker of anxiety/depression. Reduced positive affect, as measured on the PANAS for the high AD group, and theories such as reduced emotionality for positive

stimuli (Rottenberg et al., 2005) suggest this group could have an embodied response to positive meaning (Havas et al., 2007; Niedenthal, 2007). For the high AD group, positive stimuli may be more difficult to integrate semantically, as positive information is incongruent with the negative-schemas and thought patterns associated with anxiety and depression. For example, Giesler et al., (1996) found when asked to choose between positive and negative feedback, people with depression opted to hear negative feedback about their personality (also see, Swann et al., 1997 for a review).

Although treatments for anxiety and depression such as cognitive behavioural therapy consist of positive feedback and re-framing negative thought-patterns, positive feedback is not always effective. Paradoxically, positive verbal feedback has been linked to exacerbated symptoms of anxiety (Holmes, Lang & Dhruvi, 2009) and reduced positive affect (Holmes, Mathews, Dalgleish & Mackintosh, 2006). As depressive and anxious symptoms are associated with reduced future positive outlook (Macleod & Byrne, 1996), and rumination (Nolen-Hoeksema, Wisco & Blair, 2008), difficulty with positive semantic integration could be a clinically significant link between cognitive biases, positive affect and symptom severity. Indeed, severe depression has been related to enhanced startle response for positively-valenced stimuli (Allen, Trinder & Brennan, 1999), which indicates, paradoxically, enhanced implicit attention/ arousal for positive stimuli.

6.14 Emotion effect: LPC, limitations & future studies

The high AD group elicited a late positivity, LPC for both positive and negative unrelated emotional word-pairs, suggesting the maintenance of anxiety/depression could be modulated by difficulty integrating positive meaning. Both positive and negatively valenced compared to neutral word-pairs elicited an LPC, indicating that the high AD group were not allocating more attentional resources to negative valence, which would be expected under a negativity bias (e.g. Beck, 2008). However, we were not measuring emotional regulation per

se therefore we cannot definitively conclude that no negativity bias would be present in these participants. Future studies could examine emotion regulation using this paradigm but assess neural networks implicated with emotional regulation such as the anterior cingulate cortex (Stevens et al., 2011), orbitrofrontal cortex (Fitzgerald et al., 2008) and striatum (Heller et al., 2009) to see whether these areas are modulated during the task. Furthermore, to further separate meaning and emotion, a task which targets more visceral responses such as a startle-probe could be administered to assess physiological arousal associated with positive and negative meaning in people with high AD.

A limitation of this study could be the inference that people with trait levels of anxiety/depression – an analogue population- would have similar cognitive biases and low levels of positive affect, as patients diagnosed with anxiety or depression. However, the electrophysiological marker for positive semantics would be consistent with models of low positive affect (Beck, 2008) and difficulty with emotion regulation (e.g. Heller et al., 2009). A follow-up study could examine semantic and emotional processing in patients with anxiety and depression. I would expect a similar result for positive semantics- a reduced N400 response, but attenuated LPC for positive incongruent emotion.

6.15 Control of prime stimulus parameters

A strength of this study was the control employed on the targets, which were repeated for semantic incongruent, emotion incongruent and semantic/ emotion congruent conditions (see Chapter 2), indicating that different ERP effects elicited could not be due to differences in physical stimuli characteristics. In addition, the targets were controlled for word parameters (see Chapter 2). However, in one condition- the semantic incongruent condition, the positive primes had higher frequency ratings than both neutral and negative primes. It is unlikely that the congruency effects elicited for the semantics is affected by the differences in frequency, as the semantic congruency effects elicited similar N400 amplitudes for each

valence, for the low AD group. Typically, higher frequency words would render a smaller amplitude of the N400, as it would be easier to integrate into a preceding context (Rugg, 1990). However, ERP analyses on the primes (Chapter 2) indicate similar N400 amplitudes for *both* positive and negative valence for the high AD group, suggesting frequency is not responsible for the lack of an N400 semantic congruency effect. Furthermore, if frequency was the mediating variable for reduced N400 response, I would expect a smaller N400 response, not an LPC. The LPC elicited for the positive semantic incongruent word-pairs was consistent with our hypothesis for the high AD group- that is, blunted positive affect, and cognitive biases would make meaning integration for positive valence more effortful.

6.16 Strength of semantic and emotion effects at posterior sites

The semantic and emotional congruency effects for this study were all larger at posterior sites, consistent with previous studies (Hajcak et al., 2012; Hinojosa et al., 2010; Federmeier & Kutas, 1999). Task demands have been associated with different distribution of effects, but the task we employed – an emotional evaluation task was consistent with centro-posterior distribution (see Fischler & Bradley, 2006 for a review). Similarly semantic priming tasks have reported larger distribution of the N400 over centro-posterior sites. Intriguingly, the N400 emotional congruency effect for positive valence was only elicited for the low AD group, and over posterior sites- similar to Herbert et al., (2008). We argue that motivational significance of the stimuli used in these tasks were not as arousing to people within the low AD group. When groups are combined the typical N400 congruency effect is present for semantics and a typical LPC effect for positive and negative valence. However, the N400 emotional congruency effect is apparent only for the low AD group- who do not elicit an LPC.

6.17 Summary & conclusions

The aim of this thesis was to examine the interface between cognition and emotion using a series of different methodological paradigms (explicit, implicit, memory recall, electrophysiological). This thesis revealed that cognition (memory recall, cultural cognition, meaning and emotive language) modulates emotional responses, supporting a psychological constructivist argument. For example, the context of language acquisition, as well as age and order of language acquisition modulated the relationship between emotion and cognition. In Chapter 3 (IAT), strength of implicit and explicit identity was dissociated, based on order and context of language acquisition, suggesting cultural affinity can be modulated even in early highly proficient bilinguals. Similarly, in Chapter 4, context and order of language acquisition revealed memory x valence interactions but only in the second language of L2 Welsh bilinguals. Additionally, autobiographical memory structure was modulated by context of language learning and L2 proficiency. Although the experimental chapters did not assess the physiological aspects of an emotional response per se, the stimuli used were rated for hedonic valence and arousal, which are related to underlying motivational systems in the brain (approach vs. avoidance; e.g. Lang & Bradley, 2010). It is therefore reasonable to assume that the findings elicited in Chapter 3 (cultural context and language acquisition), Chapter 4 (autobiographical memory recall) and Chapter 5 (ERP components) reflect the relationship between emotional arousal and cognition. Despite not measuring physiological arousal using skin conductance responses, monitoring heart rate, or looking at startle reflexes; Chapter 5 provides a direct neural correlate of emotional responses. The LPC is sensitive to both valence and arousal of emotional stimuli, and as such the amplitude of the LPC is typically larger to stimuli that is more emotionally arousing (e.g. Bradley, 2000; Lang & Bradley, 2010; Herbert et al., 2006; Herbert et al., 2008). In fact Herbert et al., (2008) examined the amplitude of the LPC to emotional words and found that the startle reflex (an

autonomic nervous system response) correlated with the amplitude of the LPC. Therefore, we can reasonably conclude that the LPC findings in Chapter 5 are an index of emotional processing.

A strength of the current thesis was the level of control afforded to word parameters between Welsh and English languages for all tasks, which have not previously been controlled in implicit association tasks. Furthermore, the control employed over levels of trait anxiety/ depression in the ERP study, which has not been explicitly measured previously. Levels of traits anxiety/ depression were related to interactions between valence x congruency, in participants recruited from University participants, indicating the importance of controlling for these dimensions.

Both Chapters 3 + 4 were consistent with psychological constructivist accounts of emotion - that is context and experiential factors interacted with core affect, which could to some degree explain our findings. In addition, the similarity of arousal levels between L1/ L2 in the autobiographical memory study were more consistent with evolutionary accounts, as a negativity bias was apparent for each language, regardless of context and proficiency. However, the ERP Chapter - 5 was more consistent with embodied models of cognition, when interpreting the N400 effect as an inhibition rather than integration account. In Chapter 5, we were able to assess emotion and cognition interactions using semantic and emotional priming in a sample of monolinguals varying in their levels of trait anxiety/ depression. This study provided a neural measure of semantic and emotional processing, controlled for psychiatric variables. Each group had markedly different ERP responses to semantics and emotion. The low AD displayed N400 responses for all valenced semantic congruency, and an N400 emotional congruency effect for positive emotion. Conversely, for the high AD group, semantic congruency effects were modulated by valence - positive semantic incongruent word-pairs elicited an LPC, indicating meaning was integrated differentially.

Similarly, LPC effects were elicited for positive and negative emotion congruency. Taken together, these results suggest emotion and semantics interact for the high AD group, but we were able to separate these effects using ERPs, whereas emotion and cognition elicited separable effects not susceptible to valence differences for the low AD group.

These studies were not wholly suited to interpret evolutionary accounts of emotional processing, as we did not examine visceral responses such as autonomic arousal, skin conductance and startle reflexes. Future studies could examine these visceral responses as well as functional correlates of emotion processing in monolingual and bilingual speakers, which would provide a different perspective on emotion and cognition interactions. For example, in a future study we could examine whether positive or negative induced mood modulates the strength of implicit bias on an implicit association test differentially. This would provide insight into whether context, and mood can manipulate implicit cognitive responses, which would further explicate the relationship between emotion and cognition. Additionally, examining heart rate or skin conductance responses while participants undertake an implicit association test or whilst recalling autobiographical memories could provide an autonomic nervous system correlate of emotion, which we could triangulate with our findings. Indeed, we are currently using another index of physiological arousal and direct neural activity, ERPs to measure how bilinguals perceive emotional and meaningful stimuli in their first and second languages. Although we have not solved the emotion-cognition debate, the findings from this thesis support the proposition that emotion and cognition are modulated by contextual, experiential, linguistic and social factors.

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Appendices

Appendix A: Words included in EPT (Chapter 5).

Positive Targets and associated primes (S+E+; S+E-; S-E+).

	Congruent Prime	Emotion Incongruent	Semantic Incongruent	Targets POSITIVE
	S+ E+	S+ E-	S- E+	
1	EAGER	FRANTIC (-)	SLEEPING	ENTHUSIASM
2	RETURNS	DESERTED (-)	GRACIOUS	HOME
3	EMBRACE	TOUCH (N)	INTELLIGENT	KISS
4	CONTENTED	SITTING (N)	FRAGRANCE	RELAXED
5	FUN	HAVOC (-)	COMFORTABLE	JOYOUS
6	PLAY	MANIPULATIVE (-)	HEAVEN	FRIEND
7	WELL-BEING	ACCIDENT (-)	LEISURE	HEAL
8	GLORY	DEFEAT(-)	FAMILY	TRIUMPH
9	PERFORMS	ARROGANCE (-)	FAVOURITE	SUCCESS
10	SWEET	REPULSIVE (-)	JEWEL	ADORABLE
11	MARVELLED	STUPID (-)	HOUSE	BRILLIANCE
12	HILARIOUS	SNIGGER (-)	SPARKLE	LAUGHTER
13	WIN	WAR (-)	BUNNY	VICTORY
14	OVERJOYED	SHOPPING(N)	ENERGY	DELIGHT
15	CHUCKLE	MOCKING (-)	HOLIDAY	COMEDY
16	IDEA	TEACHER (N)	PUPPY	INSPIRED
17	HELPS	COMFORT (N)	LIFE	KINDNESS
18	SPIRIT	FRUIT (N)	BIRD	PASSION
19	ENJOY	BODY (N)	OCEAN	PLEASURE
20	ENCOURAGED	HANDS (N)	RELATIVES	APPLAUSE
21	FAMILIAR	DIARY (N)	GARDEN	INTIMATE
22	QUILT (N)	TIRED (-)	PRETTY	SNUGGLE
23	GENTLE	MEAT (N)	DAYLIGHT	TENDER
24	UPLIFTING	WALK (N)	FAITH	EXHILARATING
25	RECONCILIATION	QUARREL(-)	PET	REUNION
26	SMILE	READING (N)	PHOENIX	HAPPY
27	DEVOTED	CRAVE (N)	BELIEF	AFFECTION
28	FUNNY	DRY (N)	CONFIDENCE	HUMOUR
29	ATTRACTIVE	PLAIN (N)	WEEKEND	BEAUTIFUL
30	IMPRESSED	SHOCK (N)	FREEDOM	AMAZEMENT
31	PAINTING	MESS(-)	HONEST	DECORATE
32	SUNLIGHT	BLIND (-)	FRESH	DAZZLE
33	EXPLORING	TROUBLE (-)	CROWN	ADVENTURE
34	CERTIFICATES	RECEIVE (N)	TRANQUIL	REWARD
35	AMUSED	DISTASTEFUL (-)	LOVELY	JOKE
36	CUDDLES	NEEDY (-)	ENTERTAIN	HUG
37	WISH	PRIVACY (N)	RAINBOW	DESIRE
38	SAVED	CITIZEN (N)	CHRISTMAS	HEROIC
39	SUPERB	EXHIBITION (N)	FACE	OUTSTANDING
40	GREAT	RUBBISH (-)	HANDSOME	PARTY

Negative Targets and associated primes (S+E+; S+E-; S-E+).

	Congruent Prime S+ E+	Emotion Incongruent S+ E-	Semantic Incongruent S- E+	Targets NEGATIVE
1	SCARY	ANGEL (+)	PUNGENT	DEVIL
2	AFRAID	ENCOUNTER (N)	PUTRID	TERRIFIED
3	MONSTER	FAIRY (+)	JAIL	DEMON
4	STEALS	NEWS (N)	MALARIA	KIDNAPPING
5	DISTRAUGHT	RELEASE (+)	WASP	GRIEF
6	DISTRESSED	ROOM (N)	PLUMMET	TORTURE
7	BREAKS	NATURAL (+)	GREED	DISASTER
8	ILL	STOMACH (N)	PUNISHMENT	VOMIT
9	PREVENTED	CONSOLE (N)	TIMID	SUFFERING
10	CHOKED	AIR (+)	FAT	SUFFOCATE
11	BIN	WOOD (N)	BOMB	ROTTEN
12	NOBODY	ACCEPTED (+)	DECOMPOSE	REJECTED
13	BONES	FEELINGS (+)	INSOLENT	CRUSHED
14	STUCK	RESCUE (+)	BLASPHEMY	TRAPPED
15	FEAR	BREATHE (N)	HYPOCRITE	PANIC
16	TEMPER	ELEMENT (N)	POVERTY	EXPLOSIVE
17	RUIN	TOTAL (N)	RABIES	DESTRUCTION
18	DISCIPLINED	MANAGEMENT (N)	FEEBLE	ANGER
19	IGNORES	COOPERATIVE (+)	GRENADE	DEFIANT
20	MALICE	HOLD (N)	GRIME	GRUDGE
21	AGGRAVATED	POWERFUL (+)	TOMB	HOSTILE
22	HURT	HOPE (+)	POISON	DESPAIR
23	SCOLDED	INDIFFERENT (N)	TOBACCO	SHAMED
24	HUMILIATED	SHY (N)	ACHE	EMBARRASSED
25	CRUEL	PLAN (N)	LOSS	NASTY
26	SHARK	DARK (N)	FILTH	THREATENING
27	ANNOY	SOOTHE (+)	THIEF	IRRITATE
28	HARM	THRILL (+)	UGLY	DANGER
29	FALLS	GAME (+)	BETRAY	INJURY
30	WORRIED	ROLLERCOASTER (+)	FOUL	FRIGHTENED
31	EVIL	GOOD (+)	MOULD	WICKED
32	SMASH	NOVEL (N)	TUMBLE	CRIME
33	ASHAMED	RESULT (N)	BEREAVMENT	FAILURE
34	UPROAR	EXCITEMENT (+)	CEMETERY	CHAOS
35	ANNOYED	PERSON (+)	SORROW	HATRED
36	BULLY	SUBDUED (N)	WASTE	VICTIM
37	SUICIDE	WEATHER (N)	TOXIC	HORRIBLE
38	COLLAPSE	APPLIANCE (N)	AGGRESSIVE	HAZARDOUS
39	HIT	STRONG (+)	NUISANCE	ASSAULT
40	PRICKED	ROSE (+)	COWARD	THORN

Neutral Targets and associated primes (S+E+; S+E-; S-E+).

	Congruent Prime S+ E+	Emotion Incongruent S+ E-	Semantic Incongruent S- E+	Targets NEUTRAL
1	TABLE	SUBSTANTIAL (+)	LAMP	CONTENTS
2	HOW	SURGICAL (-)	LOWERED	METHOD
3	SHEET	WARMTH (+)	MAP	FABRIC
4	SHOWED	INTIMIDATING (-)	ROUTINE	POINTED
5	SEARCHES	POSSESSIONS (+)	MEASUREMENT	STORE-ROOM
6	RIGHT	SHARP (-)	MILEAGE	ANGLE
7	PISTE	TWISTED (-)	PART	SLANTED
8	RIDES	CRASH (-)	MODEST	VEHICLE
9	TOE	PEDICURE (+)	NETWORK	FOOT
10	CARVES	GRAND (+)	LOCATION	STRUCTURE
11	ADVERT	ADVICE (+)	PROFILE	LEAFLET
12	ROLL	WINE (+)	POLE	BARREL
13	COMPARE	DISAGREE (-)	THICKNESS	CONTRAST
14	LITTLE	PETITE (+)	INTERIOR	SHORTER
15	VAST	PLENTY (+)	EXTERNAL	AMOUNT
16	EATING	EMPTY (-)	FARM	BOWL
17	AROUND	NATURE (+)	BILATERAL	LANDSCAPE
18	EXTENDS	SNAPPED (-)	GEOMETRIC	STRETCHED
19	ALIGN	BALANCED (+)	CORNER	SYMMETRICAL
20	SEE	DISTANT (-)	CYLINDER	NEARBY
21	CIRCLE	CAKE (+)	PAMPHLET	DIAMETER
22	BASIN	SAILBOAT (+)	POSTER	VESSEL
23	WATCH	FATHER (+)	SOFA	TIME
24	MANOEUVRES	TEAM (+)	CRAYON	NAVIGATE
25	ROW	CORRUPT (-)	JELLY	ARRANGEMENT
26	SMALL	TIGHT (-)	PANTRY	NARROW
27	WOOLLEN	TORN (-)	BATHROOM	MATERIAL
28	LOADED	HEAVY (-)	PHASE	LIFTED
29	DIVES	SHALLOW (-)	FORK	DEPTH
30	LETTUCE	DROWN (-)	BOOT	ICEBERG
31	PUT	WORK (-)	TECHNIQUE	PLACEMENT
32	SOUTH	MISDIRECT (-)	STREET	NORTHWEST
33	SPHERICAL	ARGUMENT (-)	TRANSPORTATION	CIRCULAR
34	LAND	MOUNTAIN (+)	PENCIL	VALLEY
35	PAPER	PATROL (-)	VEST	BORDER
36	ROCK	OBSTRUCTION (-)	SHIP	BOULDER
37	NUMBER	PRESENT (+)	PASSAGE	ITEM
38	INFORMATION	TRUTH (+)	CHAIR	FACT
39	BOBBLE	DECORATION (+)	SALAD	HAIRPIN
40	TRIANGLE	TREASURE (+)	OPTION	PYRAMID

Appendix B: Words included in the autobiographical memory study (Chapter 4)

	<i>List1_English</i>	<i>List2_Welsh</i>
Positive	Busy	Saff
	Joyful	Balch
	Brave	Cryf
	Happy	Effeithlon
	Compliment	Brwdfrydig
	Helpful	Cyfeillgar
	Negative	Mistake
Nervous		Methiant
Lazy		Brifo
Wrong		Straen
Angry		Perygl
Blame		Straen

	<i>List2_English</i>	<i>List1_Welsh</i>
Positive	Safe	Dewr
	Strong	Llawen
	Friendly	Cynhorthwyol
	Proud	Hapus
	Enthusiastic	Prysur
	Efficient	Canmoliaeth
	Negative	Danger
Strange		Nerfus
Tense		Diog
Disappointed		Camgymeriad
Failure		Blin
Hurt	Bai	

Appendix C: Words included in the IAT study (Chapter 3)

	<i>English IAT</i>	<i>Welsh IAT</i>
Positive	Good	Da
	Smart	Clyfar
	Clean	Glân
	Happy	Hapus
	Strong	Cryf
Negative	Bad	Drwg
	Dumb	Twp
	Dirty	Budr
	Weak	Gwan
	Angry	Blin