INVESTIGATING LEXICAL PRIMING USING EYE TRACKING DATA – SOME "GLAD NEWS"

by

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TABLE OF CONTENTS

List of Figures

List of Tables

CHAPTER ONE: INTRODUCTION

Arguably the single most important achievement of corpus linguistics since its inception has been to reveal that language is highly phraseological - that is to say, words and structures are typically co-selected in extended and 'semi-prefabricated' units (Sinclair, 1991; Hunston & Francis, 2000; Wray & Perkins, 2000). Most of this work has been descriptive, based on data collected from investigations of corpora rather than drawing on any underlying psycholinguistic theory. However, more recently, some linguists have started to propose more psychologically oriented explanatory models. This thesis focuses on one of the most prominent of these, Hoey's theory of lexical priming (2005).

Lexical priming proposes that the phraseological nature of language is due to its speakers being repeatedly exposed to language in preexisting patterns. Over time, this exposure leads us to expect and produce elements of language based on what we have encountered before. Hoey's lexical priming theory suggests that words or phrases can be primed by lexical items related through many levels of language including, among other things, grammatical, textual and pragmatic associations. Hoey (2005) makes a number of claims about natural language which amount to an explanation for what Hoey terms 'naturalness' in language, which equates to what other scholars (e.g. Sinclair, 1991, 2003; Pawley & Syder, 1983) have termed 'idiomaticity' or 'nativelike selection'.

One of the claims made by Hoey in his construction of his theory concerns synonyms. Hoey claims that synonyms, despite their shared meanings, will

differ in terms of their collocations, colligations and semantic preferences. This study will be investigating the psychological reality of the claim that synonyms will differ in terms of their colligations - defined by Hoey as the grammatical preferences held by lexical items. These exact terms will be defined in the following in depth exploration of lexical priming and the claims which comprise it. Alongside the exploration of synonyms and their colligatory preferences, the validity of the existence of absolute synonyms will be explored through the results of this study. It has been claimed that lexical items often termed synonyms are not in fact 'absolute' synonyms (Cruse, 2000) - in response to this, there have been suggested many subtypes of synonymy. If the results of this study support Hoey's claim that synonyms have different colligatory preferences, this indicates that these synonyms cannot be fully and easily substituted for one another in any context. This would support the claim that the synonyms in use in this study are not indeed absolute, providing more evidence to support the idea that absolute synonyms are rare.

As has often been noted, Hoey's notion of priming is in many respects similar to the notion of priming as developed in psychology. However, lexical priming is not a theory based on psychological theory or evidence, but rather a corpus-driven theory which makes reference to the psychological notion of priming. Hoey backs up the various claims made throughout this theory using corpus-based analyses mostly taken from newspaper data. No experimental data was collected in the creation of this theory. The current study aims to test one of Hoey's claims by carrying out an experimental study using eye tracking. Eye tracking is a methodology at the forefront of modern

psycholinguistic research. By tracking the eye movements of a reader, eye tracking data can demonstrate which elements of a text or sentences are uncommon, problematic or unexpected for a reader. This is based on the central claim that the longer a lexical item takes to read, the more mental effort is required of the reader to recognise, access or process the item (Staub & Rayner, 2007; Rayner, 2009). The initial movements of the eye are typically subconscious for a reader (Conklin, Pellicer-Sánchez & Carrol, 2018). Due to this, eye tracking data is able to reveal a reader's first reaction to a text without the reader being able to consider their response. Eye tracking also has the ability to explore eye movements which may not be subconscious - in this way, this methodology can build a detailed picture of the different stages of processing involved in reading from recognition to integration of meaning.

This investigation will serve two purposes. By using synonyms as the stimuli for the investigation, it allows for an investigation into the psychological reality of colligations through a narrow lens by removing the semantic variable. Secondly, it allows for a close investigation into one element of the claim that synonyms will differ in terms of their collocates, colligations and semantic associations. This is not to say that the collocates and semantic associations of synonyms are not worth investigating, rather that the exclusion of these two tenets to focus only on the colligatory preferences of synonyms allowed for a more in depth analysis of a specific claim made in this theory.

This thesis will test Hoey's lexical priming theory in two key ways. There will first be an in-depth discussion of both lexical priming and the literature

surrounding the theory. There will be a discussion of traditional priming, the psycholinguistic concept that Hoey makes reference to but then moves away from in order to focus on corpus data. The concept of priming leads to the investigation of phraseological language, and how investigations into priming relations such as collocations and colligations have contributed to the literature on this topic. This has been thoroughly investigated through corpus based investigations but has recently been more thoroughly investigated through psycholinguistic techniques such as eye tracking. This technique will also be explored in detail, with reference to previous works which have sought to investigate the validity of corpus-based claims.

The second way in which this tenet of lexical priming will be investigated is through an experimental investigation into the claim through eye tracking. Stimuli for the investigation were taken from corpus data and manipulated to allow for comparisons between phrases which Hoey claims are to be expected and unexpected based on the frequency with which they occur with each other in natural language. These stimuli phrases were then embedded into an eye tracking study whereby participants' eye movements when reading both the expected and unexpected phrases could be recorded. The results of this experiment were statistically analysed and presented in a way to demonstrate what effect, if any, the expectedness of a phrase has on processing.

The impact of these results, not just on Hoey's theory but also on the surrounding field of phraseological language, are to be discussed in detail following the unpacking of these results and what they mean.

1.1 Research Aims

The broad aims of this research project are:

- To compare the nature of lexical priming as it is presented to the extant literature on priming as a psychological effect
- To explicitly test the psychological validity of lexical priming
- To consider the implications of these two investigations for a) usage-based theories of language and b) synonymy

CHAPTER TWO: LITERATURE REVIEW

2.1 Lexical Priming

Hoey is a part of the neo-Firthian tradition of corpus linguistics (Hoey, 19779; 1983; 1985; 1991a; 1991b; 1993; 1994; 1997c; 1998; 2000a; 2000b; 2001; 2003; 2004a; 2004c). This tradition has a strong empirical focus - it uses extensive amounts of corpus data to formulate and back up any claims made about the composition of a text or language. This tradition is also socially and functionally oriented. There is a focus on language at the level of discourse, bringing in context to examinations of language. The driving force of this tradition is to use corpus methods to discover new perspectives on language in use. There is also a focus on collocation, which has led to an interest in the phraseological nature of language. Many of the key scholars in this tradition – including Sinclair, Hunston, Louw, Stubbs, Teubert, Tognini-Bonelli and Hoey himself – are, or have previously been, associated with the University of Birmingham. This has led to this technique not only being known as a neo-Firthian or Sinclairian approach, but also as a Birmingham School tradition of corpus linguistics.

Lexical priming is defined by Hoey as “a new theory of the lexicon” (Hoey, 2005:1). It is a phraseological theory of language which suggests that natural language is composed of semi-fixed phrases that we are conditioned to produce and reproduce through repeated exposure. It postulates that, in opposition to traditional theories of language, the lexicon is highly structured, and it is this which gives natural language its order, rather than grammar forming the structure of language and the lexicon filling in the gaps provided. As mentioned previously, although lexical priming takes its name from the traditional concept of priming, there is actually limited engagement with mainstream priming theory in Hoey’s work. This research intends to bring the theory back to psycholinguistics with rigorous empirical testing - something necessary following Hoey’s adaptations to the theory upon which it has drawn. Lexical priming is made up of ten hypotheses, each of which makes claims about a relationship at a different level of language. The ten hypotheses are all briefly explored in the following discussion as it is important that each of the claims are understood in full so that the tenet of the theory which will eventually be explored in detail is not understood in isolation.

1. Every word is primed to occur with particular other words; these are its collocates.
2. Every word is primed to occur with particular semantic sets; these are its semantic associations.
3. Every word is primed to occur with particular pragmatic functions; these are its pragmatic associations.

4. Every word is primed to occur in (or avoid) certain grammatical positions and to occur in (or avoid) certain grammatical functions; these are its colligations.
5. Co-hyponyms and synonyms differ with respect to their collocations, semantic associations and colligations.
6. When a word is polysemous, the collocations, semantic associations and colligations of one sense of the word differ from those of its other senses.
7. Every word is primed for use in one or more grammatical roles; these are its grammatical categories.
8. Every word is primed to participate in, or avoid, particular types of cohesive relation in a discourse; these are its textual collocations.
9. Every word is primed to participate in particular semantic relations in a discourse; these are its textual semantic associations.
10. Every word is primed to participate in particular, or avoid, certain positions within the discourse; these are its textual colligations.

The ten hypotheses, taken verbatim from Hoey (2005:13)

Collocations

The concept of collocates, also referred to as collocations, has been well explored in previous literature since its conception (Firth, 1957a, 1957b, 1968; Sinclair, 1991), particularly through corpora (e.g. Williams, 2001; Hunston & Francis, 2000; Baker, Gabrielatos & McEnery, 2013; Xiao, 2015). Neo-Firthian corpus linguists have emphasised the importance of collocates as an explanation for the phraseological nature of language (e.g. Sinclair,

1990, 1991; Hoey, 2000; Hunston & Francis, 2000). Many of these explorations have been undertaken through corpus data much like Hoey's investigation. Hoey has taken this suggestion and expanded it to suggest that a word which appears commonly with another will continue to do so due to exposure to the lexical items as connected. This claim also holds strong links to the concept of traditional priming - the idea that a word will be processed faster if it is preceded by a semantically similar word is the basis of traditional semantic priming (e.g. Collins & Loftus, 1975; Meyer, 2014).

Semantic Associations

Hoey's concept of semantic associations is somewhat less researched. Sinclair (1991) proposed the similar concept of *semantic preference*. Hunston (2007) defined semantic preference as "the frequent co-occurrence of a lexical item with items expressing a particular evaluative meaning" (Hunston, 2007:266). This also applies to Hoey's *semantic association*, in broad terms. An example (Hoey, 2005) of semantic association would be the preference of the phrase *say a word against* to occur with negation, for example *Nobody would say a word against her* or *There wasn't a word said against them*. The idea that both words and semantic sets are primed to appear with other semantic sets gives rise to wider syntactic implications. Hoey states that the semantic sets with which a word is primed to appear are its semantic associations. The frequently referenced Bill Bryson sentence "SMALL PLACE is TIME DISTANCE -by VEHICLE- from LARGER PLACE" (Hoey, 2005:8) example demonstrates that semantic sets are primed to expect each other just as words are. An example of the sentence above could be "Selly

Oak is a fifteen-minute walk on foot from the University of Birmingham". The sentence serves to demonstrate that however unfamiliar the members of the semantic sets used in the sentence are, as long as they are members of the sets then the sentence will read as natural as those semantic sets are primed to occur with each other.

Pragmatic Associations

Pragmatic association occurs when a word is associated with a set of features which all serve similar pragmatic functions. For example, *sixty* is primed for pragmatic association with VAGUENESS (e.g. *about sixty, almost sixty, sixty-odd*); it is also primed for semantic association with UNITS OF TIME, UNITS OF DISTANCE and AGE (example from Hoey, 2005). As can be seen in the above examples, semantic and pragmatic associations are closely linked - so closely linked in fact that there is no definitive line between them, according to Hoey. Hoey states that this is largely down to the intuition of the researcher and links this to his theory of naturalness. Also, like semantic associations, pragmatic associations are not exclusive to words - they also affect phrases and nested clusters. Nested clusters are collocations *within* collocations; for example, the phrase *Wall Street Journal writer* contains the collocations *Wall Street* and *Wall Street Journal* and even *journal writer.* Hoey even makes the claim that nested clusters are more likely to have pragmatic associations than individual words.

Colligations

Although not an area as extensively explored as semantic associations between words or semantic sets, there is some existing research on

colligations. In particular, Sinclair has conducted significant research into colligations (Sinclair, 1972; 1990; 1991). Sinclair's definition of colligations describes the co-occurrence of a class of grammatical items with a specified node. For example, regarding the lexical item *true feelings* as a node, Sinclair notes that there is a strong colligatory preference with a possessive adjective - i.e. *her true feelings*, *my true feelings* etc. (Sinclair, 1997; discussed in Philip, 2011). Hoey uses a derivative of Halliday's (1959) definition of colligation: the relation between a word and a grammatical pattern, creating a midway relation between grammar and collocation. Just as a lexical item may be primed to co-occur with another lexical item (collocation), so also it may be primed to co-occur in or with a particular grammatical function (colligation). He goes on to make three statements, that colligation is: the grammatical company a word keeps; the grammatical functions preferred by the group in which the word participates; and the place in a sequence that a word prefers.

With regards to the grammatical company a word keeps, this element of colligations mirrors most closely the previous definition of collocates. This first tenet of Hoey's claim states that lexical items have preferences with regards to which grammatical categories - e.g. nouns or verbs - they occur with. By 'occur with', this typically means within about a three-word radius on either side of the lexical item in question - this is the norm for collocatory investigations through corpora, and Hoey has extended this to colligatory investigations. For example, the word *very* may prefer to occur directly preceding adjectives and adverbs - this is a positive colligatory preference. With regards to the grammatical functions a lexical item prefers, Hoey

conducted comparative studies on the sentence positions a word may or may not favour. The example presented was on the word *consequence.* The study showed that *consequence* was positively primed to occur in the Object position in a sentence, and negatively primed to occur in the Adjunct position in a sentence. These conclusions were drawn by comparing instances of *consequence* with instances of five randomly selected nouns for their occurrence in different grammatical functions.

Grammatical Categories

Hoey claims that each lexical item is primed for use as certain grammatical categories - such as *noun* or *verb*. This hypothesis is somewhat more controversial. It returns to his original statement of what lexical priming as a theory really is: “The theory reverses the roles of lexicon and grammar, arguing that lexis is completely and systematically structured and that grammar is an outcome of lexical structure” (Hoey, 2005:8). Hoey states that the claim that, for example, *consequence* is a noun is really a claim about its collocations, colligations and semantic associations. Its nominal status is the product of a cluster of collocations and colligations which only become visible when we stop taking it for granted that is just *is* a noun. The grammatical category we assign to a word is simply a convenient label we give to the combination of the word’s most characteristic and genre-independent primings. It is the outcome of other factors, not the starting point for linguistic description. Rather than words ‘belonging to’ a particular grammatical category, as is the case in traditional grammar, Hoey describes them as being ‘primed for use as’ a noun/verb/adjective/etc. Allowing words to be

merely ‘primed for use as’ a certain grammatical category, rather than fixed in a certain category, provides an explanation for grammatical creativity. A common example of grammatical creativity of this kind is the use of words typically primed for use as nouns as verbs, such as *to Google* (Appendix 01).

Textual Collocations

Hoey posits the existence of cohesive chains and cohesive links at the level of the text. *Cohesion* is the linking within a text which holds a text together and gives it meaning. It is related to the broader concept of *coherence*. There are two main types of cohesion: grammatical cohesion, which is based on structural content—and lexical cohesion, which is based on lexical content and background knowledge. These hypotheses make reference to lexical cohesion. Cohesive links are two items linked by textual collocation; cohesive chains are three or more items linked in this way. It is also important to note that the longer a cohesive chain is, the more it is related to the topic of the text. There are multiple relationships a cohesive chain can be composed of. The simplest of these is repetition; other examples include hyponymy, meronymy and synonymy.

Hoey claims that every word is primed to participate in particular types of cohesive relations in discourse, and that these are its textual collocations. As the name suggests, textual collocation draws on the previously established notion of collocation. Hoey has extended this notion to include two new aspects: collocation across sentences, rather than within a small window (typically three words either side of the node word); and collocation of a word with itself. This posits repetition as a type of priming. Textual collocation is

what lexis is primed for, and the effect of the activation of this priming is textual cohesion. Hoey then states that this hypothesis functions at two different levels. The first level of this hypothesis is simply whether a word is primed for cohesion of any kind or not. The second level of this hypothesis is the type of cohesion a word is primed for. Hoey provided the example that, in his corpus of *Guardian* newspaper articles, *gay* is primed for cohesion using simple repetition: *gay* will be repeated as *gay*, and then repeated as *gay*, and so on. This in contrast to replacing it with possible alternatives such as the synonym *homosexual* or the hyponym *member of the LGBTQ community.*

Textual Semantic Associations

Much like the previous textual hypothesis, textual semantic association is based on a definition from a previous hypothesis in this list. Semantic associations are the semantic sets with which a word is primed to occur. Hoey takes this definition and, much as with textual collocation, expands it to cover full texts rather than intra-sentence associations. Every lexical item may be positively or negatively primed for occurring as part of a specific type of semantic relation or in a specific textual pattern (e.g. contrast, comparison, cause-effect, problem-solution). An example of textual semantic association provided by Hoey (2005:27-28) is that in 100 instances of *sixty*, 41 were in a contrast relation, 37 were in the problem component of a problem-solution pattern and 16 were in non-contrastive comparison relations. We would therefore say that *sixty* is strongly primed for use in contrast relations and in the problem component of problem-solution patterns, and weakly primed for use in non-contrastive comparison relations.

Textual Colligations

Hoey claims that every word is primed to occur in (or avoid) certain positions within the discourse - at the beginning or end of an independently recognised section of text. These are its textual colligations. This hypothesis extends the notion of colligation to cover not only positioning within the sentence or phrase but positioning within the speaking turn, the paragraph, the conversation and the text. To demonstrate this with some examples, *consequence* is primed to avoid paragraph-initial and text-initial position, and the aforementioned example *sixty* is strongly primed to favour both sentence-initial position and text-initial position.

Polysemous Words

Polysemous words are words which have more than one meaning, with no changes to their orthography. An example of a polysemous word is *right*: it has a *correct* meaning, i.e. *You're right!*; a *legal* meaning, i.e. *I have a right to do this!*; and a *direction* meaning, i.e. *Go right at the crossroads*. The claim that different meanings of polysemous words have different primings was first postulated by Sinclair (1987). A distinctive colligational or collocational pattern indicates a separate use of the words, rather than the other way around. That is to say, "the patterns of one use of a polysemous word always distinguish it from the other uses of the word" (Hoey, 2005:81), much like how a word's preference dictates its preferred grammatical category. Hoey goes on to claim that ambiguity or humour will result from the use of a word in ways not in accordance with its primings. This brings the claim back to the

overarching theory of lexical priming - that meanings of a word are the outcomes of the word's primings, not the object of the primings.

Cohyponyms

Cohyponyms are a set of terms which share a common hypernym. For example, *poodle, dalmatian* and *dachshund* are all hyponyms of the hypernym *dog*. Hoey claims that despite this association with each other, they will behave differently with respect to their collocations, semantic associations and colligations. There are all terms which have already been defined - Hoey has taken these terms and further made the claim that lexical items which share semantic links or features will still differ in terms of these preferences.

Synonyms

Finally, as has been previously mentioned as an element of the focus of this study, Hoey claims that synonyms will differ in terms of their collocations, semantic preferences and colligations. The claims made by Hoey regarding collocations and semantic associations appear more relevant when referring to synonyms than they do when referring to cohyponyms. This is because, as the synonyms share the same meaning, there is no logical reason why they would be used in different contexts to each other. With regards to colligations, there is once again no logical reason why synonyms should behave differently in terms of their grammatical patterns. The only possible reason why this may be the case echoes Hoey's claim that this tendency to occur in different grammatical patterns is due to repeated exposure to the synonyms in particular environments. It is this claim which will be

investigated in detail throughout the rest of the study. This will be investigated alongside a secondary claim, which regards the nature of synonymy.

There have been a variety of types of synonymy suggested in previous literature. These include, but are not limited to, propositional synonymy and near-synonymy (Cruse, 2000), plesionymy (Yuliawati & Indira, 2019), similonymy (Bawcom, 2003) and cognitive synonymy (Cruse, 1986). The way each of these types of synonymy have been defined has also varied over the years. Some lexicologists see all types of synonyms as vaguely as “the grouping of words based on idea” (Yuliawati & Indira, 2019:4685). Cruse (2002) detailed his own definitions for the types of synonyms he named. Propositional synonyms may differ in terms of the fields of discourse in which they occur - for example, using *thigh* in lay usage, as opposed to *tibula* in the medical profession - their expressive meaning, or in stylistics, such as the level of formality at which each lexical item occurs (Cruse, 2000). Near-synonyms cannot be fully substituted for each other and can be discriminated on aspects of denotation, connotation, implicature or register (Cruse, 2000; see also DiMarco, Hirst & Stede, 1993). Finally, cognitive synonyms are words which preserve their truth when interchanged but may differ in terms of their expressive meaning, style or register – for example, the term *mommy* tends to occur more frequently in the register of young children than the cognitive synonym *mother*, though the meaning remains the same (Cruse, 1986). Plesionymy (Yuliawati & Indira, 2019) can be defined as a type of near synonymy, even “near but peculiar synonymy” (Bray, Gibbons & McHale, 2012:58), whereas similonymy (Bawcom, 2003) is a broader definition,

encompassing synonyms, near-synonyms and other strong semantic relationships between words. For the purposes of this exploration, and all further discussion of synonyms in this research, the definition of synonym will be expanded to also include the term similonym (Bawcom, 2003) to mean words that are similar enough to be considered synonyms but may have slight differences in their definitions.

Each of the ten hypotheses outlined above, up to and including the claims regarding synonymy, comprise lexical priming as a whole theory. Although primarily a theory conceptualised based on corpus data, Hoey drew briefly on the fundamental concept of traditional priming - that the presence of one lexical item or feature can serve to speed up recognition of a target lexical item - in order to create his lexical priming theory. Traditional priming as borne from psychological research is a multifaceted field of research which, much like lexical priming, functions at a variety of levels of language.

2.2 Traditional Priming

As Hoey's lexical priming has drawn on traditional priming, this section will explore the original psychological concept of priming and consider whether and to what extent Hoey's (2005) theory of lexical priming relates to or interacts with traditional priming theory. Hoey (2005) briefly discusses traditional priming in the following quote: "The notion of semantic priming is used to discuss the way a 'priming' word may be used to provoke a particular 'target' word" (Hoey, 2005:8). Various kinds of priming exist at all levels of language. These include semantic priming, which has formed the basis of much work on the structure of the mental lexicon; orthographic and

phonological priming, which have often been explored together; and syntactic priming, demonstrating that these kinds of relationships are also applicable to structures above the level of the word.

Orthographic and Phonological Priming

There is a large body of research which supports the existence of priming at the levels of orthography and phonology (Zeguers, Snellings, Huizenga & van der Molen, 2014, 2018; Frisson, Bélanger & Rayner, 2014). The two phenomena are often explored together as the two are “inevitably confounded in Roman letter languages” (Lupker, Mariko & Perea, 2015:1). In order to account for this effect, many studies have investigated phonological priming through bilingual speakers where the two languages in question are written using different alphabets (Lupker, Mariko & Perea, 2015; Ando, Matsuki, Sheridan & Jared, 2015).

Ando, Matsuki, Sheridan & Jared, (2015) investigated the presence of phonological priming effects on Japanese-English bilinguals through a lexical decision task. Lexical decision tasks typically involve the presentation of a prime word, followed (after a pause which can vary in length known as the Stimulus Onset Asynchrony (SOA)) by a string of letters. Participants must decide whether the string of letters is a real word or a nonsense string of letters. Priming theory dictates that participants should recognise associated target words faster than they recognise unrelated target words and nonsensical strings of letters. In this case, the Japanese elements of the stimuli were written in Katana script so as to remove the effect of orthography on the phonological investigation. The results of the study showed a robust

effect for phonological priming where the participants show positive priming effects when the prime and target are not semantically associated but were phonologically similar. Similarly, Lupker, Mariko & Perea (2015) investigated phonological priming effects with Japanese-English bilinguals through a same-different task, also utilising the Katana script to account for the effect of orthography. They, too, found a significant effect of the same direction for phonological priming.

The existence of orthographic and phonological priming has also been investigated through young language learners. Zeguers et al. (2018) investigated the existence of these types of priming with children at incremental levels of reading development (second, fourth and sixth grade). Results of this study demonstrated a robust effect for orthographical priming whereby orthographically similar lexical items were processed faster. There was no such effect for phonological priming - in this way, phonological priming has been used to explore the rates at which young language learners develop their phonological activation skills. Frisson, Bélanger & Rayner (2014) investigated phonological and orthographic priming together through different word pairs - some which had strong phonological and weak orthographical links, such as *fruit-chute*, and some which had strong orthographical and weak phonological links, such as *bear-gear*. The results of this fast priming task showed strong orthographic priming effects with much weaker phonological priming effects. This may be explained by the fact that the lexical decision task was focussed on written language rather than spoken.

Syntactic Priming

There have also been previous investigations into the existence priming at higher levels of language. For example, there have been investigations into the existence of syntactic priming (Bock, 1986; Bock et al., 2007; Pickering & Branigan, 1999; Branigan, Pickering & Cleland, 1999; Clifton & Staub, 2011; Rowland et al., 2012; Messenger et al., 2012). Syntactic, or structural, priming is typically defined as the tendency for a language user to repeat or reuse a phrase or sentence structure they have recently encountered in their own language use. For example, participants primed with a double object dative such as *The student gave the teacher a hard look* are more likely to produce, subsequently, a double object dative of their own, even when the two sentences share no semantic overlap, such as *The dog brought her owner a stick* (Rowland et al., 2012). As with orthographic and phonological priming, syntactic priming does not always function in isolation. Rowland et al. (2012) found that there was a "lexical boost" (Rowland et al., 2012:1) in their results, where an overlap in the specific lexical item used caused a further positive priming effect. This is evidence of semantic priming.

Semantic Priming

Semantic priming is a priming effect based on meaning - one of the most simple examples is that a language user, having read *dog*, will go on to read *cat* faster than an unrelated word as a result, because the two are semantically related (Meyer, 2014). There have been many studies conducted which support the existence of semantic priming, including through lexical decision tasks (Dannenbring & Briand, 1982; Bentin,

McCarthy & Wood, 1985; Neely, Keefe, & Ross, 1989; Holcomb, & Neville, 1990; Perea & Rosa, 2002). Each of the studies showed robust effects for semantic priming, in different conditions (Perea & Rosa, 2002), visually and auditorily (Holcomb & Neville, 1990) and electrophysiologically (Bentin, McCarthy & Wood, 1985), demonstrating the robustness of semantic priming effects on speeding up reaction times in many different environments.

For example, Fischler (1977) explored the effects of semantic priming through a lexical decision task. Participants were shown words which occur frequently together in natural language, termed *associates* (e.g. *cat-dog*), words not typically associated in use, but which had been rated by other participants as semantically similar (e.g. *wife-nurse*), and unrelated control pairs (e.g. *stem-bread*). Results of this study showed that both semantically similar and associated words were processed faster than unrelated control pairs. This supports the existence of a processing advantage for semantically associated pairs in the mental lexicon. The interaction between semantically related and associated lexical pairs will be explored in greater depth later in this review, particularly in relation to activation in the mental lexicon (Cramer, 1969; Anisfeld & Knapp, 1968).

The evidence collected which supports the existence of priming effects are able to show that these kinds of features exist. If phonological priming is observed, for example, this supports the claim that discrete phonological features are represented in the mental lexicon. The same can be applied to orthographic and syntactic features. This supports the existence of a complex

mental lexicon which stored not just semantic features of lexical items but also features from other levels of language which apply to the lexical item.

There is a large body of research which has investigated the processes behind semantic priming and what this means for the structure of the mental lexicon. The mental lexicon can be defined as a way linguistic information about lexical items is stored in the mind, such as its semantic features, orthography, pronunciation and grammatical behaviours (Jackendoff, 2002). There is some discussion surrounding the structure of the mental lexicon. One theory about how it is structured suggests it is like a dictionary (e.g. Miller, 1986); another, semantic network theory, suggests that the mental lexicon is a collection of complex neural circuits - it is this theory which has proposed the idea of spreading activation theory (Hutchison, 2003). Spreading activation theory suggests that the more links there are between two concepts in the mental lexicon, the faster one concept will be activated by the other. It also states that the more links a concept has, the weaker its activations will be. For example, *cherry* will activate *red* relatively quickly as (a) it is a primary feature of *cherry*, and (b) *cherry* has relatively few associations. Alternatively, *red* will not activate *cherry* as quickly as *red* is a feature of many concepts and thus has many links, of which *cherry* is only one (Hutchison, 2003). This demonstrates the directional nature of priming - just because one lexical item will prime a target lexical items does not mean that target item will prime the first lexical item. It is not just semantic priming effects which can activation spreading activation - it can also be activated by neighbourhood effects. Neighbours are defined as lexical items which could be confused with the target word due to overlapping orthographic features.

For example, the word *game* has the neighbours *came, dame, fame, lame, name, same, tame, gale, gape, gate,* and *gave,* giving it a neighbourhood size of 11 as 11 new lexical items can be made by changing just 1 letter of the lexical item game (example from Andrews, 1989). This concept is highly related to the concept of orthographic priming. The spreading activation theory also recognises that a lexical item is more likely to be activated the more frequently it appears in natural language (Foster & Chambers, 1973; Whaley, 1978). It is important to note that the following discussion of priming will focus on semantic priming, but this is not the only reason why we may recognise or process a target item faster than typically. For example, some of the other effects which may affect word processing times include word length (e.g. Baddeley, Thomson & Buchanan, 1975; O'Regan & Jacobs, 1992), word frequency (e.g. Zipf, 1936; Smilek, Sinnett & Kingstone, 2014; Whitford, 2017) and regularity of spelling (Baron & Strawson, 1976). Each of these variables may have an effect on how quickly a target word is processed, regardless of its relation to the prime word (Warren, 2012). There has also been discussion surrounding the different types of priming which can arise depending on the speed with which the target is presented following the prime.

Posner & Snyder (1975a, 1975b) proposed the existence of priming effects at two levels - automatic and strategic. Automatic priming is often discussed in relation to spreading activation theory and termed Automatic Spreading Activation (ASA); it functions under the assumption that the structure of the mental lexicon as a collection of complex neural circuits. Priming caused by ASA is subconscious and occurs early in the reading process. Automatic

priming effects can be investigated in a number of ways. Lexical decision tasks with short Stimulus Onset Asynchronies (SOAs) demonstrate the effect of automatic priming effectively as the time between exposure to the prime and exposure to the target is typically too short for systematic priming effects to activate (Neely, 1977; den Heyer et al., 1983; de Groot, 1984; Verfaellie et al., 1990). Similarly, automatic priming effects are said to be reflected in early measures of eye tracking studies (to be discussed further in the following sections; Inhoff, 1984; Altarriba et al., 1996; Paterson, Liversedge & Underwood, 1999; Conklin, Pellicer-Sánchez & Carrol, 2018). It has been suggested from research that automatic priming effects can only ever decrease processing time by facilitating priming - they cannot increase processing time by inhibiting priming effects (Posner & Snyder, 1975a, 1975b).

Strategic priming effects, in contrast, take longer to activate. They are dependent on participants' conscious attention to the prime. Strategic priming effects have been argued to be due to one of two processes - expectancy and postlexical checking (Posner & Snyder, 1975a). Expectancy accounts claim that participants use a prime to generate a set of expectations about the upcoming target (Becker, 1980; Posner and Snyder, 1975a). If the target meets these expectations, reaction times are decreased, if not, reaction times are increased because participants must devote resources to activate the node for a word not present in the expectancy set. This demonstrates that, unlike automatic priming, strategic priming can both facilitate and inhibit priming effects (Posner and Snyder, 1975a, 1975b). Strategic priming due to postlexical processing suggests that both expected targets unexpected

targets are accessed at the same rate, but the following decision to accept or reject the target as a word - as in a lexical decision task - is influenced by the aforementioned expectations (Forster, 1981). In contrast to automatic priming effects, strategic priming effects are expected to occur with longer SOAs as they must result from subjects' conscious appreciation of the prime and its context, which takes time. Regardless of whether the priming effects are automatic or strategic, the same question of how priming functions (i.e. how the presence of a prime speeds up the processing of a target) arises.

There are two main schools of thought when it comes to how semantic priming functions. These are holistic and distributed (Hutchison, 2003). The distributed theory suggests that concepts are not units in themselves, but they are a series of features linked together (Masson, 1995; Moss et al., 1995; Plaut, 1995). This theory draws exclusively on semantic features to predict primes and connections between concepts. To illustrate this with an example, the lexical item *pig* would strongly prime the lexical item *cow* as they share many semantic features - *is an animal, has four legs, lives on a farm,* etc. There are a variety of different types of close feature-based connections between concepts. Three of the most commonly discussed interconceptual relationships are synonyms, antonyms and category cohyponyms (Hutchison, 2003), which necessarily have high levels of feature overlap. Synonyms, by definition, should share all features with each other - there are no semantic differences in their definitions. For example, *happy* has the key features *+emotion, +positive*. Its synonym *pleased* shares these features exactly. Similarly, antonyms share all but one feature - they are opposite in one respect. For example, *happy* has the features *+emotion,*

+positive, whereas *unhappy* has the features *+emotion, -positive*. Finally, category cohyponyms all share a common hypernym, or category head, but will differ by one or more features to differentiate between them. For example, the category *fruit* will contain cohyponyms such as *banana* and *orange*. Both share the feature *+fruit*, but differ in features such as *acidic,* where orange is *+acidic* and banana is *-acidic*, or *yellow*, where *banana* is *+yellow* and orange is *-yellow*.

Alternatively, the holistic theory posits that the semantic features which make up a concept do not exist in isolation but that the combination of the features and the discoursal environments in which the concepts occur create a whole concept (Anderson, 1983; Collins & Loftus, 1975; McNamara, 1992). This is a theory where the syntactic network - where typical grammatical constructions and what were thought of as 'rules' - works in connection with the lexical network, or mental lexicon - where the bulk of vocabulary, and the associated definitions, are stored. The more connections concepts have with each other, the more associated the concepts, and the more likely one concept will prime another. In this theory, 'connections' can mean features or learned associations (Collins & Loftus, 1975). Semantic features, discussed above, include descriptive elements which apply to both lexical items (prime and target). Learned associations, on the other hand, are links between lexical items which are not semantic in nature but instead borne of repeated exposure to the two lexical items together. For example, the lexical items *hot chocolate* and *autumn* may prime each other if a language user typically drinks that beverage in that season. Learned associations are specific to each person - for example, in warmer countries, this association is not likely

to exist as much, nor would it exist as strongly for people who do not enjoy hot chocolate. This is just one example of how learned associations are different for every language user.

One of the central questions in the field of traditional priming is whether priming is due to association strength or feature overlap (Hutchison, 2003; Collins & Loftus, 1975; Quillian; 1967). These two theories align with the previously discussed schools of thought - distributed theories of semantic priming emphasise feature overlap (also known as feature priming and semantic priming), whereas holistic methods are based on association strength. Association strength is the suggestion that links between concepts are strengthened by the frequency at which two concepts occur in discourse together (Hutchison, 2003; Perea & Rosa, 2002). Conversely, feature overlap is the suggestion that links between concepts are strengthened by the number of features they have in common, such as the previously mentioned examples of synonyms, antonyms and category coordinates (Hutchison, 2003; Moss et al., 1995). What quickly becomes apparent is that concepts tend to fall into both categories, i.e. they have features in common and often occur together in discourse. One example of this could be the terms *doctor* and *nurse*. They both share many features, such as *job*, *medical*, *work in hospital*, etc. They also, however, commonly occur together in discourse. For example, if asked to discuss their stay at a hospital, a language user might mention the *doctors and nurses* they met. If asked what career they want in the future, a child might say *doctor or nurse*. This demonstrates the difficulty in saying with any certainty which type of relation between words is responsible for any priming effect between them. This creates difficulties in

the discussion over which hypothesis is correct. As a response to this and following a series of experiments which attempted to separate associative and feature primings, some researchers have started to opt for a “hybrid” (Perea & Rosa, 2002:192) approach to semantic priming. The relationships between prime and target may not be the same, may function at different speeds and levels of consciousness, but both are ultimately valid. Another response to this is a combination of the two approaches, suggesting that feature-based priming is perpetually present, but that there is an *associative boost* (Moss et al., 1994) when these feature-based primes and targets are also frequently associated in discourse.

Hoey’s lexical priming (2005) draws on the same or similar processes as traditional semantic priming. It is now pertinent to discuss whether or not Hoey’s theory of lexical priming should be considered a type of priming in its own right. On traditional priming, Hoey states that “the focus in psycholinguistic discussion is on the relationship between the prime and the target, rather than on the priming itself per se. In the discussion that follows, however, priming is seen as a property of the word and what is primed to occur [i.e. the target] is seen as shedding light on the priming item [i.e. the prime] rather than the other way around” (Hoey, 2005:8). In response to this, Hoey first introduces his theory as “a new theory of the lexicon, which amounts to a new theory of language. The theory reverses the roles of lexicon and grammar, arguing that lexis is completely and systematically structured and that grammar is an outcome of lexical structure” (Hoey, 2005:8). Pace-Sigge & Patterson (2017; see also Pace-Sigge, 2013) note that Hoey has drawn briefly on the theory of traditional priming (Quillian,

1967) in order to formulate the theory of lexical priming. He has taken the basic concept, expanded it, and applied it to many levels of language. Lexical priming is used as an explanation for observations noted by Hoey in corpus data. It is important to consider whether the aforementioned theories of semantic priming be applied to Hoey's theory of lexical priming. Working under the assumption that they can, in accordance with preliminary research conducted by Collins & Loftus (1975) and the underlying theory of association-based priming, it is important to consider which of the aforementioned types of priming are relevant to or consistent with Hoey's theory.

For many reasons, lexical priming should be considered as priming based on association strength rather than based on feature overlap. The first of these reasons is that Hoey's theory was born from corpus data. Hoey posited his theory based on repeated patterns of language found in pre-existing discourse, and suggests that through exposure to these patterns, we are primed to expect lexical items in certain environments, sentence types, etc. This suggestion would not function without the presupposition that relationships between concepts are based on association strength rather than feature overlap.

Furthermore, this association does not apply solely to individual words, but also to semantic categories, such as VEHICLE or DISTANCE in Hoey's example sentence "SMALL PLACE be a NUMBER-TIME-JOURNEY (by VEHICLE) from LARGER PLACE" (Hoey, 2005:18). However, another key element of lexical priming is that semantically similar words will have different

primings. It is claimed that individual words which share hypernyms (i.e. cohyponyms) will have different primings. For example, according to lexical priming, *maple* and *oak* will have different primings, despite sharing the hypernym *tree*. This accounts for concepts having general primings but individual words having their own primings. Association strength also allows for the flexibility seen in lexical priming. Hoey states that primes are often personal - items may have specific primes that would make no sense to a speaker without context. Feature overlap would not be able to account for this as easily, as speakers should assign roughly the same features to concepts, even across languages.

This research will work under the assumption that priming is born primarily of association strength. This is due to both the compelling evidence from previous research (Collins & Loftus, 1975; Perea & Rosa, 2002; Hutchison, 2003) and the similarities this approach shares with Hoey's lexical priming - the theory in question. With regards to whether lexical priming can also be considered to be 'priming' in the traditional sense, this research will work under the assumption that it should be. Of course, lexical priming has expanded traditional priming, adding specifics and new terms, but its key function - that one lexical item can make a language user expect another - remains unchanged. Hoey made reference to this psychological phenomenon in his attempt at an explanation for the phraseological nature of language. This in itself was uncommon - most evidence collected in support of the phraseological nature of language has tended to come directly from corpora.

2.3 Phraseology

The field of traditional semantic priming has been able to provide robust evidence to support the claim that the presence of one lexical item can serve to speed up the processing time of a target item (Collins & Loftus, 1975; Hutchison, 2003). The findings of semantic priming, which state that lexical items have preferences to occur with associated lexical items, resonate with the one of the main findings of corpus linguistics, which is that language is highly phraseological (Sinclair, 1991; Hunston & Francis, 2000; Wray & Perkins, 2000). Phraseology encompasses a group of language theories which, at their core, claim that language is not structured by individual words and a set of rules into which they can all fit. Phraseological approaches to language propose that lexical items are typically chosen as part of 'semi-prefabricated' units (Sinclair, 1991). The composition of the phrases, and the sequence in which they occur, is dictated by experiences with and exposure to language. This means there is overlap between phraseological approaches to language and usage-based approaches to language (Bybee, 2006a, 2006b). Hoey's (2005) lexical priming theory is his attempt at explaining the phraseological nature of language. Interest in the phraseological nature of language came primarily from corpus-based research (e.g. Sinclair, 1991; Hunston & Francis, 2000).

Many different approaches to language have taken into account the phraseological nature of language. One such approach which discusses the formulaic nature of language comes from Wray & Perkins (2000). They define each phrase which composes formulaic language as "a sequence, continuous or discontinuous, of words or other meaning elements, which is,

or appears to be, prefabricated: that is, stored and retrieved whole from memory at the time of use, rather than being subject to generation or analysis by the language grammar." (Wray & Perkins, 2000:1). This claim - that phrases as defined by Wray & Perkins are stored as single units in the mental lexicon - is psycholinguistic in nature and highlights the link between the structure of a language and how this is reflected in how the components of the language are stored and accessed (see also Wray, 2012; Siyanovia-Chanturia, 2015).

Another approach which attempts to account for the phraseological nature of language is Sinclair's (1991) idiom principle. The idiom principle states that a language user has a number of preconstructed phrases available to them, and that the production of texts involves putting together these preconstructed multi-word combinations (Sinclair, 1991). This is in contrast to the open-choice principle (Sinclair, 1991) which rejects the existence of preconstructed phrases and instead suggests that language users have free choice in the words they use. The idiom principle is a usage-based theory of language which attempts to serve as an explanation for the phraseological nature of language (Erman & Warren, 2000; Siyanova-Chanturia & Martinez, 2015). It is based on the claim that the more frequently a language user is exposed to a phrase or word cluster, the more likely they are to store the words in the phrase as associated in the mental lexicon and, once stored, reproduce them in natural speech.

Hunston & Francis (2000) proposed the theory of pattern grammar (see also Francis, Hunston & Manning, 1996, 1997). Pattern grammar was created as

an extension of Sinclair's (1991) theories of language and is another corpus-based approach to the phraseological nature of language. Sinclair proposed that there should be no distinction made between form and meaning - pattern grammar took this concept and constructed itself around it. The approach claims that each word has a set of patterns in which it frequently occurs which describe typical contexts in which it is used. Often these are separate for different word senses, such as polysemous words - this emphasises the importance of colligatory preferences in the construction of grammar and links closely to Hoey's (2005) claim concerning colligatory preferences of polysemous words. Furthermore, Bybee's (2006a; 2006b; 2010) usage-based theory of language further proposes that cognitive representations of language are based on experiences with it, and as such commonly occurring multi word units will be stored as their own units alongside the individual words of which they are composed. She claims that what that creates the links in a mental language network is actual language usage. This theory in particular highlights the link between usage-based theories of language and phraseological theories of language - both emphasise the effect of using and experiencing language on processing and consequently producing language.

The importance of frequency of occurrence of elements of language is emphasised in these approaches as this is how patterns of language and grammar are reinforced. Two of the earliest proponents of a usage-based approach to language acquisition, in opposition to the traditional word-and-grammar approaches of the past (e.g. Chomsky, 1965) are Bybee (1985; 2010) and Langacker (1987). Bybee's work highlights the importance of the effects of frequency on acquisition and speed of processing. Similarly,

Langacker (1987) outlines the basis for the cognitive grammar approach which would go on to underlie many of the usage-based approaches to language.

There have been even more approaches to language which have attempted to account for the inherent phraseological nature of language (see Stubbs, 2007; Teubert & Krishnamurthy, 2007; Tognini-Bonelli, 2001). Many of these have drawn on corpus data in order to make their claims. The implications of corpus-based evidence for the phraseological nature of language is not only relevant to the discussion surrounding the relationship between lexicon and grammar. Although previous works on the structure of language have explicitly stated they make no claims about how this structure is reflected in the mental lexicon (Sinclair, 1991; Hunston & Francis, 2000; Teubert & Krishnamurthy, 2007) these works have led to the suggestion that the motivation behind the phraseological nature of language is related to the structure of the mental lexicon (e.g. Wray & Perkins, 2000; Hoey, 2005). The mental lexicon has been discussed in relation to traditional priming regarding the ways in which lexical items are stored in the mind. However, the phraseological research conducted on corpora has given rise to the suggestion that some lexical units are not stored as individual words at all - the links between them are so strong that they are stored as short phrases instead (Bybee, 2006a, 2006b, 2010; Tremblay & Baayen, 2010).

There have been previous works which have explicitly explored phraseological approaches to language through psycholinguistic research. Many of these studies have involved lexical decision tasks (Hodgson, 1991;

McKoon & Ratcliff, 1992; Williams, 1996; Ellis et al., 2009; Durrant & Doherty, 2010). Hodgson (1991) investigated collocational priming through a lexical decision task. Participants were presented with collocates such as *private property*, which he termed *phrasal associates*. These phrasal associates were collected by Hodgson himself - he used his instinct as a native speaker of English to choose the pairs. The SOA in the study was short; this has been shown in past research to indicate the effects of automatic priming rather than strategic priming (Posner & Snyder, 1975a, 1975b; Neely, 1977; den Heyer et al., 1983; de Groot, 1984). An automatic priming effect was found whereby when the priming word was a phrasal associate with the following word, the target was identified more quickly (as a word, rather than a non-word) than control lexical items. The fact that this result was automatic demonstrates that collocational priming is likely subconscious and occurs early in the reading process.

Similarly, Williams (1996) explored the effect of collocational priming through another lexical decision task. The stimuli used for this study were lexical items graded as *highly familiar* to each other by a group of native speaking participants, such as *knife - fork*. The SOA was similarly short in this study as the investigation was focussing on the extent to which priming effects are present in the automatic stage of recognition. The results of the study showed that *highly familiar* lexical items were recognised faster than the control items. This supports the claim that there are priming effects for highly familiar lexical items - collocates - and that these effects are automatic.

McKoon & Ratcliffe (1992) conducted their own lexical decision task investigating priming effects of collocations. The collocates were collected from a small corpus and chosen based on the frequency with which they occur together. This study, too, found priming effects for frequently co-occurring lexical items, stating that the frequency with which lexical items co-occur in large corpora could potentially predict priming effects (McKoon & Ratcliffe, 1992). Although their own study was conducted using stimuli collected from only a small corpus, they recognised the potential for investigating collocations in this way. The use of a corpus (of any size) to choose the stimuli for this study sets this project apart from previous work in this area - these collocates were statistically supported, rather than being based on researcher instinct (Hodgson, 1991) or individual participant responses (Williams, 1996).

More recently, Ellis et al. (2009) investigated the effect of collocation strength on recognition times in a lexical decision task. They compared the recognition times of high frequency pairs - both adverb+adjective and verb+object - and low frequency pairs. Both types of high frequency pairs were recognised faster than low frequency pairs in this lexical decision task. The results of this study support the existence of priming effects for highly collocated pairs. Durrant & Doherty (2010) have also investigated the psychological reality of the priming effects of high frequency collocations through a lexical decision task. The high frequency collocations were consistently recognised faster than the low frequency controls through a task where the SOAs were short in length. This shows a significant automatic priming effect for high frequency collocations. This supports Hodgson (1991)

and WIlliams (1996) in their findings that collocational priming tends to function at the automatic stage of recognition, early in the process.

There have been other psycholinguistic techniques employed alongside lexical decision tasks to explore how phraseological language is processed (Tremblay & Baayen, 2010; Tremblay et al., 2011). Tremblay et al. (2011) investigated this phenomenon through a series of self-paced reading tasks. Sentences which contained lexical bundles - sequences of lexical items which commonly occur together in natural language - were compared to sentences which did not contain lexical bundles. An example of a lexical bundle used in the study is *I don't know whether*. The bundles were collected from the *British National Corpus* using the *Variations in English Words and Phrases* search engine. The results of all the tasks showed that sentences which contained lexical bundles were read faster than their controls, indicating a significant processing advantage for lexical bundles and the sentences which contained them. These tasks were followed by a series of word and sentence recall experiments, in which more sentences which contained lexical bundles were recalled correctly than sentences which did not contain lexical bundles. This, too, demonstrates an advantage for the processing of highly associated lexical items in the mental lexicon.

Tremblay & Baayen (2010) also used a controlled recall task to explore the existence of a processing advantage for collocated items. Participants were presented with sequences of four lexical items - some of which were highly collocated, such as *in the middle of*, and some of which were not, such as *by the end of*. The strength of the collocation was measured by taking the

sequences from the *British National Corpus* and their frequencies from the *Variations in English Words and Phrases* search engine, ensuring that these collocations were statistically supported. Results showed that highly collocated sequences were recalled more frequently than the sequences which were not highly collocated. This supports the claim that highly collocated sequences are stored as whole units in the mental lexicon.

As has been discussed, much of the research which has been conducted on the priming effects of phrasal frequency have been investigated through lexical decision tasks, self-paced reading tasks and recall tasks (Hodgson, 1991; McKoon & Ratcliff, 1992; Williams, 1996; Ellis et al., 2009; Durrant & Doherty, 2010; Tremblay & Baayen, 2010; Tremblay et al., 2011). Although all valid psycholinguistic techniques which can be used to explore both automatic and strategic priming effects, there are other psycholinguistic techniques which could be of use in this broader investigation of how phrasal language is stored and accessed in the mental lexicon. One technique which is at the forefront of such psycholinguistic research is eye tracking.

2.4 Eye Tracking

In order to investigate how or whether the patterns found in grammar are reflected in the mental lexicon, there have been a variety of investigations run with eye tracking (e.g. Yi, Lu & Ma, 2017; Siyanova-Chanturia, Conklin & Schmitt, 2011; Valsecchi et al., 2013; Choi, 2017). Eye tracking is a modern psychological technique. In the field of linguistics, it is used to gain an insight into how we process language in the mind. Eye tracking as a methodology functions under the assumption that eye movements provide an index of

attention (Rayner, 2009). The length of time spent fixated on one section of text, be it a word, multi word unit (MWU), sentence or longer piece of text, is taken to be indicative of how much cognitive effort is being expended to process the input at the fixation point (Staub & Rayner, 2007). This is in line with the eye-mind hypothesis (Just & Carpenter, 1980), which claims that there is no delay between what is being fixated on and what is being processed - that is to say that when a reader looks at a word or lexical item they are processing it for exactly as long as the fixation lasts.

The key aspects of eye movements are fixations (where an eye focuses) saccades (where an eye moves, i.e. where it skips over between fixations) and regressions (where eye goes back to focus on a region it has already passed through); the part of the text which is being investigated by the researcher is the interest area (Rayner, Slattery & Belanger, 2010; all terms and definitions from Conklin, Pellicer-Sánchez & Carrol, 2018).

There are two main ways data from an eye tracking experiment can be investigated - through early measures and late measures. Early and late measures are understood to reflect different stages of reading processing - early measures are indicative of highly automatic word recognition and lexical access process, whereas late measures indicate more conscious, controlled, strategic processes (Inhoff, 1984; Altarriba et al., 1996; Paterson, Liversedge & Underwood, 1999; Conklin, Pellicer-Sánchez & Carrol, 2018). Some early measures which can be explored when textual stimuli are in use are first fixation duration, which indicates the length (in ms) of the first fixation on a text or an interest area, and first pass reading time, which indicates the

length (in ms) of time taken for a text or region of interest to be read the first time (Conklin, Pellicer-Sánchez & Carrol, 2018). Some late measures which can be explored in text-based studies are total reading time of the interest area and whole text, which indicate the length (in ms) of time spent reading the section of text in total, including first pass reading time, re-reading time and second pass reading time. Two other commonly explored late measures are interest area fixation count and trial fixation count, which indicate the number of fixations made on a section of text throughout the reading of the section (Conklin, Pellicer-Sánchez & Carrol, 2018).

There are also some measures categorised as intermediate measures as they are typically indicative of difficulty when first encountering an item and the consequent time taken to overcome that difficulty (Clifton, Staub & Rayner, 2007). These measures all involve regressions: regressions out of an interest area - how many times a regression from the critical word to the preceding text was made; regressions into an interest area - how many times a regression from a later part of a sentence was made back into the interest area. These can be considered in terms of total regression path duration, which indicates the time spent on a critical word before the reader moves past the critical word to the right (Conklin, Pellicer-Sánchez & Carrol, 2018).

Those measures which focus on the whole of a text are known as global measures; those which focus only on a word or short phrase, typically the interest area of the study, are known as local measures. Global measures are taken to indicate the property of a text as a whole, particularly regarding the overall mental effort required to process the text. This is typically

collected in terms of total fixation counts and reading times and translates to the level of difficulty the text presents. However, global measures looked at in isolation are not able to indicate where in the text the difficulty arises. These measures are only able to provide tangible results when compared to themselves in two different environments - they cannot be looked at in isolation. For example, it cannot be said simply that “the total reading time was long”, it must be said that “the total reading time was longer in condition x than in condition y”. Furthermore, it should be remembered that measures are not independent - for example, first fixation duration is part of first pass reading time, which is in turn part of total reading time. This emphasises the importance of exploring multiple measures at different levels (i.e. early and late, local and global) in order to get a full picture of the reading patterns evident.

Eye tracking has been used in the past to explore frequency effects on words (Rayner & Duffy, 1986; Inhoff & Rayner, 1986; Rayner & Raney, 1996; Inhoff et al., 2008). This is due to the fact that frequency is one of the central tenets of usage-based theories of language.

Rayner & Raney (1996) have explored the effect of word frequency on processing ease through eye movements. They investigated this claim both when participants were asked to complete a natural reading task and when they were asked to complete a search task on a text. Eye movements were recorded as subjects either read a text or searched through texts for a target word. In the reading task, there was a robust word frequency effect wherein readers looked longer at low-frequency words than at high-frequency words.

However, there was no frequency effect in the search task. The results suggest that decisions to move the eyes during natural reading are made on a different basis than they are during visual search. That is to say, when comprehending the meaning of the text is not relevant, the trigger to move the eyes is different from what it is in reading for comprehension. In this case, it would seem that a simple decision as to whether or not the currently fixated word was the search target would suffice. These results demonstrate that the effects of frequency and semantics are not always important in eye tracking tasks. In this study, when the meaning of the target word was insignificant, the frequency of the words also became insignificant in terms of processing time. This indicates that the processes used to identify lexical items are complex and can be altered to the reader's will. The insignificance of the meaning of the target item links this study well to the topic of synonymy explored in this discussion of lexical priming. The semantic variable was removed and there were still significant differences in processing time without it. This demonstrates that even during some natural reading tasks, the semantics of a target word may not have a significant effect and may be superceded by effects of other levels of language such as grammatical.

Inhoff has done previous work on the effect of word frequency on processing times of elements of compound words, as well as on full words in context (Inhoff & Rayner, 1986; Inhoff & Topolski, 1994; Inhoff, Briihl & Schwartz, 1996; Inhoff, Radach & Heller, 2000). Inhoff & Rayner (1986), for example, explored the effect of word frequency on the processing of the parafoveal word during reading. The parafoveal word is the word to the right of the focal word during natural reading. Data on fixations on the parafoveal word were

collected. Parafoveal words - some of high frequency, some of low frequency - were embedded in sentences which participants were asked to read naturally. If the fixations were shorter or less frequent on the parafoveal word, this would indicate that participants were able to collect all information they required about the lexical item by looking at the preceding word. The results showed shorter fixation durations on high-frequency parafoveal target words than on low-frequency parafoveal target words. This indicates less difficulty processing more frequent words. These results are in alignment with frequency- and usage-based theories of language – high frequency words were recognised more readily than low frequency words, often just by fixations on the preceding word.

Rayner & Duffy (1986) have specifically explored fixation durations in relation to both frequency and ambiguity. This too was an eye tracking paper which aimed at further exploring the effect of frequency on processing, looking to support a usage-based theory of language. Two experiments were conducted throughout this investigation. The target words were embedded in sentences for participants to read. The first experiment explored the effect of frequency on reading time of target words. The second experiment explored the effect of ambiguity of a target word had on processing time. The results of the two experiments were clear - there was a clear effect for frequency on processing time, where a higher frequency word would result in shorter reading times, as well as an effect for ambiguity on processing time whereby if a word was ambiguous it would result in longer processing times. These results link closely to Hoey's claim that polysemous words are likely to have different collocations, colligations and semantic preferences - if this weren't

the case, there wouldn't be a delay in processing when words are ambiguous or have multiple meanings. The results suggest that word frequency and the presence of two highly likely meanings may affect lexical access.

Inhoff et al. (2008) conducted an in-depth exploration of compound words in English - e.g. *deathbed*, *humankind* - and the effect that the frequency of each element of the compound in natural language had on reading time and eye movements. There is a strong link between compound words and strongly collocated phrases, which function as the basis of the structure of language in phraseological approaches. The compound words were treated as having a dominant and nondominant elements - the dominant element being the lexeme which primarily defines the meaning of the compound word. In the above examples, the dominant lexemes are *bed* - as that is the noun which is under description - and *human*, the root of the word *humankind*. The effect of the frequency of both the dominant and nondominant lexemes in natural language on the processing speed of the compound word was explored. This was explored alongside the effect of the position of the dominant lexeme - at the start or end of the word. Three tasks were used—lexical decision, naming, and eye tracking when sentence reading—all of which focused on the effects of lexeme frequency as a function of lexeme dominance. This combination of methodologies meant this research was able to provide a variety of results to explore the effect of frequency on compound word processing. The results showed a significant frequency effect for the dominant lexeme in all three tasks whereby the more significant a lexeme was, the shorter the processing times. Eye movements during sentence reading further revealed larger word frequency effects for the dominant

lexeme via several measures, including the duration of the first fixation on a compound word.

Cutter et al. (2014) investigated the existence of priming effects on spaced compounds. Spaced compounds were defined as two frequently co-occurring words which refer to a single concept, such as *teddy bear*. Given their close relation, this project theorised that such multi word units may have a unified lexical entry - as well as the lexicon containing separate entries for the words *teddy* and *bear* it may also contain one for *teddy bear*. This possibility is consistent with theories explaining how compound words, such as *blackbird*, are processed (Rayner & Duffy, 1986). Participants were asked to read sentences into which spaced compounds had been embedded. The results showed that the space compounds were often processed as one unit when recognised in the parafovea. These findings suggest that the two constituent words of spaced compounds are processed as part of a larger lexical unit during natural reading.

Recently, eye tracking has been used to investigate phraseological theories of language through multi word units (MWUs; Meyer & Schvaneveldt, 1971; Yi, Lu & Ma, 2017; Siyanova-Chanturia, Conklin & Schmitt, 2011; Valsecchi et al., 2013; Carrol & Conklin, 2014a, 2014b, 2017 Choi, 2017). Yi, Lu and Ma (2017) explored the effects of, among other variables, phrasal frequency - the frequency with which a phrase appears together - on reading times. This was an eye tracking study conducted on Chinese speaking participants. The study found that phrasal frequency had significant effects for all four measures - some local, some global, some early, some late - explored in this

study wherein an increase in frequency resulted in a decrease in processing time. The paper was able to provide support for the robustness of frequency effects on MWUs. These results led the paper to conclude in support of a phraseological claim that exposure to language patterns affects consequent language processing.

Similarly, Sonbul (2015) explored what effect phrasal frequency has on the speed at which a participant is able to read and process a sentence which contains the pair. This was explored through an eye tracking study wherein both early measures - including first pass reading time - and late measures - including total reading time - were explored. This paper found a significant effect of frequency on first pass reading times where increased frequency led to decreased reading times. This further supports the underlying claim of usage-based theories which is that frequency of exposure to language elements is key to language usage. However, the results also showed that the effect of frequency was not significant in relation to the late measure, total reading time. The fact that the paper found that participants were sensitive to collocational frequency in early measures but not in late measures led to the conclusion that collocations are not entirely fixed phrases. When reading an unexpected word combination, readers initially spend more time dealing with it, but once they incorporate it into a more general sentence structure, they tend to read non attested phrases equally fast. Sonbul refers to this as “schemata” (Tomasello, 2000; referenced in Sonbul, 2015:432). They suggest that readers, once recognising that although a pair of words is not familiar to them exactly, are able to "generalize the common ‘schema’ to the

novel … pair" (Sonbul, 2015:432). This provides a psychologically driven explanation as to why results of early and late measures analyses may differ.

Siyanova-Chanturia, Conklin & Van Heuven (2011) also investigated the effect of phrasal frequency on processing times. This was explored through an eye tracking experiment conducted on both native and non-native speakers of English. Participants were asked to read three-word binomial sequences - e.g. *bride and groom* - while their eye movements were recorded. The results were investigated both for the effect of phrasal frequency on processing times and for the effect of word order on processing times. In order to explore the effect of word order, three-word binomials which had a strong preference for appearing in one order over the other were explored in their preferred order and in their reversed order - for example, *bride and groom* compared to *groom and bride*. The results of this investigation would give an indication as to the colligatory preferences of the individual words in the binomial. The results of the study showed a robust effect for both phrasal frequency and word order on processing times for both native speakers and high proficiency non-native speakers. However, the frequencies of the content words of the binomial phrases and their reversed forms were not significant predictors of reading speed. This shows that it is the frequency of the entire phrase, and not the frequency of the individual words, which was having an effect on reading speed.

Conklin and Carrol (2016) also explored the impact of word order on reading time of frequently occurring binomial sequences. An example of the binomial sequences explored was *king and queen,* which occurs significantly more

frequently than its counterpart *queen and king*, according to corpus data collected. Binomial sequences with no set order were used as a control group - such as *goats and pigs* or *pigs and goats* where, according to corpus data collected, neither word order was significantly more common than the other. This question of whether the word order of binomials would have an effect on processing time was investigated using eye tracking. The binomials in their expected order were embedded within three short stories. The binomials were seen once in their expected form, and once in their unexpected form. The results of this investigation showed a significant effect of word order on processing difficulty in L1 speakers of English whereby when the binomials were presented in their expected order, they were read significantly faster than their unexpected counterparts. This can be compared to the lack of difference in processing time for either word order of invented forms (e.g. the aforementioned *goats and pigs* or *pigs and goats*). The order does not have any semantic impact but is still registered by native speakers - this demonstrates that grammatical changes may impact the processing of a phrase.

Alongside this primary study, short-term effects of binomial word-order were also explored. A binomial in which neither order was significantly more common than the other - such as *wires and pipes* - was repeated in the same order throughout a text. It was then reversed - to *pipes and wires* - at the end of the text. Original items were seen between 1 and 5 times, then the reversed form was seen once. Participants showed that repeated short-term exposure to word order had a significant effect on processing whereby reversed forms were processed significantly more slowly than the original

binomials. This further demonstrates the importance of word order and the frequency with which language users are exposed to multi-word sequences. Both of these studies explored the nativelike selection phenomenon (Pawley & Syder, 1983). This theory of nativelike selection is similar to Hoey's (2005) theory of naturalness. It takes into account a variety of aspects of language - in this case, for example, word order - and argues that each of the aspects impact how native speakers of a language make choices about their language production. It is these choices which result in native speakers producing what Hoey would call 'natural' language.

The literature demonstrates a growing interest in the exploration of multi word units as a possible explanation for the phraseological nature of language. Many of these papers have utilised eye tracking as a method to explore this phenomenon as it is a technique at the forefront of psychological research. There have been a number of studies conducted which have sought to explore some of the central tenets of phraseological approaches to language structure, such as frequency and phrasal frequency (Inhoff & Rayner, 1986; Rayner & Raney, 1996; Yi, Lu and Ma, 2017; Siyanova-Chanturia, Conklin & Van Heuven, 2011; Sonbul, 2015; Vilkaite, 2016; Carrol & Conklin, 2019). To date, there have been no studies conducted to specifically investigate any novel element of Hoey's lexical priming theory which are psychologically motivated. This study aims to use eye tracking to investigate the psychological reality of synonyms and their colligatory preferences, based on Hoey's claim in his theory of lexical priming that they will differ despite the lack of difference in meaning. This review of the surrounding literature has led to the construction of more specific research questions for this study,

leading on from the research aims stated previously. The specific research questions are:

- Does eye-tracking data support the psychological validity of synonyms differing in terms of their colligatory preferences, in accordance with lexical priming?
- Do local and global measures of reading reflect colligation preferences?
- How do the results of this study contribute to the discussion surrounding synonymy?

CHAPTER THREE: METHODOLOGY

An eye tracking study was created in order to investigate Hoey's claim that synonyms will differ in terms of their colligatory preferences. This section will outline the steps which were taken to create the study for this experiment. It will first cover how the pilot study was run, then the collection of the data which would dictate the collection of the stimuli for the study. Finally, each of these things will culminate in how the main study was realised.

Throughout the rest of the study, three variables will be referred to - Expectedness, Frequency and Naturalness. Here, Expectedness refers to the frequency with which a colligatory pair is likely to occur - the more frequently the colligatory pair is to occur, the more a participant is likely to expect to read it, hence Expectedness. This echoes the previously used term phrasal frequency but allows for flexibility in terms of what the phrase consists of. This term was introduced to differentiate between this phenomenon and Frequency - how common the lexical item in question is in natural language, according to corpora. Finally, Naturalness refers to whether the stimuli sentences used in the study was taken verbatim from natural language - Natural - or manipulated in terms of its synonym - Unnatural. These terms will be used throughout the study, particularly in the analysis stages.

3.1 The Pilot Study

The first step was to choose which synonyms would be explored in the pilot study. There was a logical way to select which adjective patterns should be explored, rather than basing the decision on researcher instinct. The Collins

CoBuild Dictionary group (grammar.collinsdictionary.com, last updated 2019) have collected and categorised every possible grammatical structure an adjective can occur in based on their own corpus, the Bank of English. This full list was taken and, where possible, combined the patterns into categories - for example, *ADJ for N* and *ADJ from N* both became *ADJ PREP N*. This allowed for clearer exploration of colligative patterns rather than just collocational relationships. The final set of grammatical patterns is included below (Table 01):

ADJ PREP N	ADJ PREP V	it V NADJ
DET ADJ	V it ADJ TO -INF	it V-LINK ADJ PREP N
it V-LINK ADJ	V it as ADJ TO-INF	as ADJ as
ADJ N	V it ADJ that	It V N as ADJ that
ADJ that	V it as ADJ that	N ADJ
V-LINK ADJ	ADJ -ING	V it ADJ for N TO-INF
ADJ TO-INF	ADJ wh-	There V_LINK PRN ADJ PREP N
There V_LINK PRN ADJ PREP -ING	There V_LINK PRN ADJ PREP N	

Table 01: Grammatical patterns for adjectives as listed on grammar.collinsdictionary.com

Each of the patterns came with a list of which types of adjectives appeared in these patterns. A full example is included in Figure 01:

Pattern:	It	V	ADJ	to-inf
Example:	It	is	easy	to see what he means

Adjectives with this pattern belong to the following meaning groups:

The 'accurate' and 'illogical' group	The 'important' group
The 'easy' and 'difficult' group	The 'legal' group
The 'selfish' and 'dangerous' group	The 'funny' group
The 'exciting' and 'safe' group	The 'enough' group
The 'surprising' and 'interesting' group	

Figure 01: An example of which sets of adjectives appear in the pattern 'It V ADJ to-inf'

This allowed for further, clearer categorisation of the synonyms which would be chosen for this project - each name of the groups served as the node for a set of synonyms. Just one of these was chosen for the pilot study. The category chosen was the *happy* category, also listed as the *delighted* category with some overlap in members. This was a random selection from the categories available as there was no reason to choose one category over another at this point. The listed members of this adjectival category are included below:

Amused, Cheerful, Chuffed, Content, Delighted, Ecstatic, Glad, Grateful, Gratified, Happy, Honoured, Jolly, Joyous, Keen, Overjoyed, Pleased, Privileged, Proud, Relieved, Thankful, Thrilled

These adjectives were then explored for their frequency in the written BNC - only the written texts were used as Hoey's claims were all based on written language rather than spoken. *Chuffed, honoured* and *gratified* were then excluded as there were fewer than 100 instances of them in their adjectival

form in the BNC. *Grateful, keen, privileged, proud, relieved* and *thankful* were also excluded as this researcher deemed their meanings too different or specific to count as close enough synonyms of *happy* or *delighted*. This left the following set of adjectives, all worth investigating as synonyms of *happy* (in order of frequency in the written BNC):

Happy: Pleased, Glad, Delighted, Content, Cheerful, Amused, Jolly, Thrilled, Ecstatic, Joyous, Overjoyed

This set of adjectives was run through each of the adjectival patterns to confirm in which of them they occurred. These were listed in Table 02. The pattern *as ADJ as* was also excluded as the synonyms showed no difference in how they behaved regarding this pattern. The final set of synonyms and their patterns were explored, and the results of the exploration are included in Table 02:

Synonym	Freq	DET ADJ	ADJ N	N V ADJ	ADJ TO-INF	ADJ that	V ADJ
happy	9496	12.60%	19.10%	10.20%	15.20%	1.40%	33.50%
pleased	3712	0.60%	0.90%	22.10%	34.20%	6.40%	54.50%
glad	3238	0.60%	0.90%	45.60%	25.80%	10.50%	68.10%
delighted	2250	3.60%	4.00%	35.80%	24.70%	8.60%	72.80%
content	1160	0%	0%	10.40%	36.10%	1.20%	56.40%
cheerful	1058	21.40%	30.70%	1.60%	0%	0.20%	14.70%
amused	636	11.30%	24.50%	10.10%	5.80%	0.60%	37.90%
jolly	395	33.40%	37.20%	1.50%	0%	0%	7.10%
thrilled	293	0%	0.30%	32.40%	10.60%	5.10%	72.00%
ecstatic	238	18.10%	33.20%	8.40%	0.80%	1.30%	20.20%
joyous	161	40.40%	58.40%	1.20%	1.20%	0%	9.30%
overjoyed	126	1.60%	2.40%	19.80%	12.70%	4.80%	59.50%

Table 02: The results of the corpus exploration of 'happy' synonyms and their preferred patterns

There are some figures in Table 02 that are noticeably higher than others in the pattern - this indicates a positive colligation. This also allowed for identification of negative collocations, shown when a figure in the table is noticeably lower than others in the pattern. With regards to how the synonyms act with respect to each other, the key behaviour patterns are noted below:

Pleased, glad, delighted and *overjoyed* all behave similarly

Cheerful, jolly and *joyous* all behave similarly

Ecstatic and *amused* both behave similarly

Happy, content and *thrilled* do not behave similarly to any others.

What this means is that each of the synonyms which share patterns should be able to be swapped around, and the only thing which should affect reading patterns is the frequency of the synonyms. There can also be swapping between these patterns providing that the synonym in question also collocates positively/negatively with the grammatical pattern.

Frequency is well-established as an important aspect of language processing in eye tracking studies (Rayner & Duffy, 1986; Rayner & Raney, 1996; Inhoff et al., 2008). The frequency of a lexical item in natural language tends to affect the processing time of the lexical item in eye tracking tasks - the processing time decreases as the frequency increases (e.g. Inhoff & Rayner, 1986; Rayner & Raney; 1996). If this effect was apparent in this study, it could potentially influence the results in an undesirable way. For example, with regards to the stimuli at hand as can be seen from Table 02, *happy* is

much more frequent than any of its synonyms in the BNC, with a total of 9496 instances. Even the second most frequent synonym, *pleased*, only occurs 3712 times. The frequencies then decrease until the least frequent synonym included in this study, *overjoyed*, which occurs 126 times. The best way this could be accounted for in terms of choosing the data was to not allow manipulation between two synonyms with significantly different frequencies. That is to say, synonyms in the stimuli sentences should not be swapped for synonyms which are significantly more frequent than they are. For example, do not replace *overjoyed* (126) with *happy* (9496) in the *ADJ that* pattern because even though *happy* (9496) is less likely to occur in that pattern, it is so much more frequent in natural language that it is likely that it will take less mental effort to recognise and access in the mental lexicon, reducing the impact of the frequency of the synonyms in that pattern. Similarly, synonyms should not be swapped for synonyms which are significantly less frequent than they are. For example, do not replace *happy* (9496) with *overjoyed* (126) in the *DET ADJ* pattern because this could cause longer fixations because *overjoyed* (126) is so much less frequent than *happy* (9496).

The synonyms were searched for in the British National Corpus. Examples of the sentences in the relevant grammatical patterns were taken from the corpus and compiled. Two counterbalanced lists were prepared so that each participant only saw one version of each stimulus sentence. As each sentence would be repeated - once with its intended synonym, and once with a different synonym - it was important that the participants were not shown both instances for each synonym. This was to ensure that participants would

not become aware of the focus of the study and increase the effect of subject awareness. If a participant is aware of the purpose of a study, this could have an effect on early measure results The stimuli sentences were to be collected of the most likely patterns where a synonym less likely to occur in that pattern would replace the original synonym, as in the examples below, the originals of which were taken from the BNC:

Natural sentence: I had the impression, though, that he was not **a happy** man.

Unnatural sentence: I had the impression, though, that he was not **a glad** man.

In order to ensure that the behaviour of the reader was not solely based on the naturalness of the sentence, examples were also found of synonyms in patterns which were not common to them. These were then manipulated to include a synonym which *does* commonly appear in that pattern:

Natural sentence: Air traffic confirmed the **glad news** that one was hanging down.

Unnatural sentence: Air traffic confirmed the **happy news** that one was hanging down.

This process was continued until each synonym had at least one stimulus sentence drawn from the corpora. The full list of stimuli - including Natural sentences and their concordance lines, and their corresponding Unnatural manipulations - is included in Appendix 02. There were two possible sets of data with which the participants could be presented. To save time, however,

both of the data sets used the same filler stimuli. The filler stimuli were all idioms as they may prove noticeable for the participants, making it less likely that they will realise the true purpose of the study. These counterbalanced data sets were compiled according to the following guidelines, to make them as equal as possible:

- Natural sentences were all split up from their corresponding Unnatural manipulations

- The data sets were composed of 50% (40) Natural sentences, 50% (40) Unnatural sentences

- 50% (20) of the Natural sentences were positive colligations

- 50% (20) of the Natural sentences were negative colligations

- 50% (20) of the Unnatural sentences were positive colligations

- 50% (20) of the Unnatural sentences were negative colligations

The final data sets in full are included in Appendices 03 and 04. The full set of filler sentences (50), which was added to both data sets, is included in Appendix 05.

At this point it is important to note that the above steps which refer to the collection of synonyms as stimuli were also repeated so that a collection of cohyponyms as stimuli were also collected. This can be seen in the full data sets in Appendices 04 and 05. The steps matched those above and the term which functioned as the head of the category of cohyponyms was SKILLED JOB OR OCCUPATION, a category explored by Hoey himself (2005).

However, as will be detailed below, this element was discounted from the main study and as such it would be of little relevance to include all the details here.

The study was set up according to suggested parameters in Conklin, Pellicer-Sánchez & Carrol (2018). These parameters are specific to static, text-based eye tracking studies for word, phrase or sentence-based critical regions. The stimuli sentence was presented as black text on a white background. The font used was Courier New as all letters take up the same amount of horizontal space. The font was size 14pt. The sentences were presented in the centre of the screen with a sizeable margin either side. The experiment was run on an SR Research Eyelink 1000+ eye-tracker. Using Eyelink (version 5.15) and set up using Experiment Builder (version 2.2.61). The data was then analysed using Data Viewer (version 3.2.48). These steps were all repeated and the parameters were all followed when the main study was run.

Prior to the experiment, the participants were given a consent form (Appendix 06). An introductory screen gave the participant brief instructions, which would move on when the participant pressed the spacebar. The researcher then calibrated the eye tracking equipment to the gaze of the participant. This was done through a 9-point calibration, followed by a 9-point validation. This was followed by a reminder of the instructions for the participant. There were then five trial sentences, each preceded by a drift correct screen. This was done to ensure the participant's gaze was as accurate as possible for each sentence. 25% of sentences were followed by a comprehension question which participants were required to answer by pressing stickered Y/N keys

on the keyboard. The purpose of the comprehension questions was to ensure participants pay close attention to the sentences, in case they are tested on them afterwards. The eye tracking equipment was then recalibrated. The 130 real sentences were then run, each also preceded by a drift correct screen. Some sentences were followed by a comprehension question. There was then a final screen thanking the participant. At any time during the pilot the equipment could have been recalibrated, for example if the participant moved their head or if the equipment couldn't detect their gaze.

Each version of the pilot study was run twice so a total of four data sets were collected. The participants of the pilot study were then asked for some informal verbal feedback on the study. This was done in order to gauge how comfortable the participants were and how successful the distractor stimuli were. There were some key aspects of the study which the pilot indicated could be changed or improved. The most important aspect of the study which the pilot indicated should be changed was the narrowing of the focus from cohyponyms and synonyms to only synonyms. Following difficulties which arose from the collection of the stimuli it became apparent that more significant data would be collected if the focus was on synonyms. This would really put Hoey's claim concerning colligation to the test as the variable of semantics has been minimised, if not eliminated.

There were some practical aspects of the study which will also be adjusted following the pilot. Even though only two stimuli sets were investigated, the lexical items were repeated and duplicated to the extent that there were over

130 sentences in the pilot study. This took each participant an average of 20-30 minutes to complete. As the main study will be investigating more than two stimuli sets, the number of examples of each lexical item would be reduced to ensure that participants will not get fatigued. Also bearing participant fatigue in mind, the main study would include fewer overall stimuli sentences, reducing the number from 135 to 100. A final change implemented to ensure participants do not get fatigued, fewer comprehension questions would be included - although they serve a purpose in terms of getting participants to focus and read the stimuli sentences accurately, they also significantly slow down the rate of completion. 10% of stimuli sentences would be followed by comprehension questions, rather than 25%. As previously mentioned, the stimuli words were repeated frequently. In order to ensure participants do not become aware of what is being investigated, this would be significantly reduced in the main study.

3.2 The Main Study

This section will outline the steps taken to collect the stimuli, manipulate them and categorise them. The technical details of the construction and running of the study remain unchanged from the pilot study.

The initial list of synonym sets was collected through a multistep process. First, the decision was made to only focus on adjectival synonyms. This was to allow for a simpler stimuli collection process and more substantial data collection on just one element of Hoey's theory. It was decided that the best way to choose the synonyms so the choices weren't completely arbitrary was to simply choose the 10 adjectives with synonyms which occurred most

frequently in the written BNC. Therefore, the second step involved using the written BNC as the data set, to bring up the most common adjectives in order of frequency using a preexisting list (Leech et al., 2001).

There were some initial guidelines which were followed in the collection of the stimuli adjectives. It was important to choose adjectives which only occurred in the grammatical category *adjective*, and not in other grammatical categories - for example, the lexical item *general* was considered, but would too often be used in its noun form, i.e. *Here comes the general*. A similar issue occurred with adjectives which were polysemous, such as *long* - the uses in *It has been a long time* and *It's a long piece of wood* are too different to be counted as one, but there would be no way of automatically differentiating between them in a corpus search. Therefore, for practicality, it was decided that no polysemous words would be investigated. There was also the obvious stipulation that the adjective must have multiple synonyms in order to be counted. The fifteen most common adjectives, all of which had more than two synonyms, were collected and compiled into a list:

Good, Old, Different, Possible, Large, Difficult, Simple, Bad, Important, Similar, Strong, Serious, Dark, Cold, Successful.

At least three synonyms were chosen for each synonym set. This was to allow for the manipulation of the stimuli sentences while avoiding excessive repetition. Not every synonym set contained the same number of synonyms - this was acceptable because the sets were not being compared to each other.

Although the initial sets of synonyms were chosen on the basis that they were the most frequent, the same criteria were not applied when selecting the individual words in each category. It was not important that each synonym was particularly frequent, but it was important that their frequencies were similar to each other. This would allow for the swapping of synonyms in the stimuli sentences while minimising the impact of word frequency. To illustrate this with an example: if one reader was presented with the sentence *It was a small parcel*, and another with *It was a miniscule parcel*, it is likely that the word *miniscule* would take longer for a reader to process based on its relative frequency (*small*, 39578; *miniscule*, 20), regardless of the frequency with which it occurs in the grammatical construction. This was an issue gleaned from the collection of the stimuli for the pilot study. It was also important that the synonyms were not too different in length - longer words will lead to more and/or longer fixations (Conklin, Pellicer-Sánchez & Carrol, 2018). The synonyms exchanged for each other were never more than five letters different in length to account for this variable.

It was based on this decision that the set *small* was excluded completely as the frequencies within the set were too divergent. It also meant that the set *large* had two smaller sets within it - one set where the average frequency was around 300 instances, and another where the average frequency was around 3000 instances. As long as the synonyms were not swapped between these subsets, this was acceptable, and allowed for more data collection. Additionally, none of the most popular synonyms (the hypernyms of the synonym sets) were able to be included as members of their own sets - their frequencies were consistently significantly higher than any of their synonyms,

so this would not allow for manipulation later on. The synonym sets and their frequencies are included in Table 04 below:

Stimuli Set Head	Frequency of Stimuli Set Head in BNC	Stimuli Set Member	Frequency of Stimuli Set Member in BNC
Excellent	**6029**	Positive Valuable Wonderful	**7572** **3679** **3977**
Old	**46857**	Ancient Elderly	**4688** **4623**
Different	**42386**	Contrasting Divergent Disparate	**344** **226** **293**
Important	**35793**	Crucial Essential Vital	**4267** **8358** **4862**
Possible	**32099**	Achievable Conceivable Probable Viable	**176** **363** **1165** **887**
Large	**32920**	Enormous Massive Vast Sizable Gigantic Hefty	**3715** **3996** **4398** **456** **385** **318**
Difficult	**19506**	Tricky Challenging Demanding Troublesome	**541** **413** **472** **413**
Simple	**12858**	Facile Effortless Uncomplex	**104** **164** **173**
Bad	**11410**	Evil Immoral Vile	**798** **302** **245**
Important		Crucial Vital Essential	**4267** **8358** **4862**
Similar	**17545**	Akin Alike Analogous	**403** **167** **513**
Serious	**11399**	Sincere Severe Austere	**440** **402** **288**
Dark	**5491**	Dingy Murky Darkened	**131** **219** **275**
Cold	**5975**	Chilly Freezing Frozen Frosty	**290** **714** **882** **193**
Successful	**10235**	Prosperous Fruitful Rewarding	**665** **430** **321**

Table 04: Synonym sets, their members and their frequencies in the BNC

The next step was to find the grammatical patterns in which the stimuli occur. This process was also altered from the pilot study. A key issue to note which wasn't discovered until the pilot study was run was the fact that often, grammatical categories overlapped. This made identifying the regions of interest difficult when analysing the data from the pilot study. For example, *DET ADJ N* was a category in the pilot study, but so was *ADJ N*, which overlaps with the aforementioned category. For example, the phrase *The yellow jumper* would fit both patterns, and be counted twice. Similarly, categories which dictate what preceded the focal adjective, such as *V ADJ*, would overlap with which dictate what would follow the focal adjective, such as *ADJ N*. For example, the phrase *to be good boys* would fit both patterns and be counted twice. To solve these problems, all grammatical categories included only dictated what *followed* the focal adjective; no categories explored anything which *preceded* the focal adjective. For example, *ADJ N* could be explored, as could *ADJ that*, but *V ADJ* could not.

The final stage was to collect the frequencies for each of the synonyms in each of the grammatical patterns using the BNC. Once all of these frequencies had been collected, they were used to identify synonyms within sets which had sufficiently different frequencies in one grammatical pattern - where one synonym occurred frequently in a grammatical pattern, and one did not. The figures from this stage of the investigation, including the frequency of each synonym in the BNC and the frequency with which it occurs in the grammatical pattern in question, are all detailed in Appendix 07.

These were used to identify which synonyms would be extracted and used as sentence-length stimuli in the final study.

Just as with the pilot study, a total of four subgroups were collected. The first group, labelled the Natural + Expected (NE) group, was collected by taking synonyms which occurred frequently in a particular grammatical pattern, and finding an example sentence in the BNC which included the synonym in the aforementioned grammatical pattern. The second group, the Unexpected + Unnatural (UU) group, was collected by taking the sentences from the NE group, and replacing the synonym with a synonym which is unlikely to occur in that grammatical pattern. This group can be seen as a manipulation of the first group. The third group was collected in a similar way to the first. Synonyms which occurred *infrequently* - but not *never* - in a particular grammatical pattern were collected, and an example sentence from the BNC was found which had this synonym in the grammatical pattern. This was the Natural + Unexpected (NU) group. And, finally the fourth group can again be seen as a manipulation of the previous group. The sentences were taken and the synonyms replaced by ones which typically *would* occur in those grammatical patterns. This formed the Unnatural + Expected group (UE).

If Hoey's lexical priming hypothesis has any psychological validity, both groups which are Expected should be processed faster than those which are Unexpected. This should happen regardless of the Natural/Unnatural status. The reason this was included was to diminish the impact of Naturalness on the reading times and to provide another variable to analyse. The four subgroups were collected and arranged over four counterbalanced lists.

Each dataset contained equal amount of the four subgroups, and only ever one half of the sentence-manipulation pairs. This was to ensure that participants were not familiar with the sentence structures.

31 native English-speaking participants were recruited, with normal or corrected-to-normal vision. Participants received a £10 voucher for participating. All procedures for running the main study were the same as for the pilot study.

CHAPTER FOUR: ANALYSIS AND RESULTS

The data were first cleaned using the four-stage procedure of the Eyelink Data Viewer software - fixations shorter than 100ms and longer than 800ms were removed, because short fixations tend to reflect oculomotor programming, and fixations longer than 800ms are due to momentary loss of concentration or track loss (Morrison,1984). No participant files were removed from the data. All data were analysed using R (version 3.6.1; R Core Team, 2012).

Local and global measures can be analysed to investigate different aspects of processing. For example, local measures show the impact of the stimuli at its source, while global measures show the impact of the stimuli on reanalysis of information and discourse-level integration (Roberts & Siyanova-Chanturia, 2013; Vilkaite, 2016). Similarly, early and late measures can be indicative of different stages of processing. Early measures reflect automatic lexical access processes while late measures reflect integration of overall meaning into wider context (Altarriba et al., 1996; Inhoff, 1984; Paterson, Liversedge & Underwood, 1999; Staub & Rayner, 2007). Therefore, this project made sure to explore local, global, early and late measures. Three local measures were chosen for this analysis. These were Interest Area First Pass Reading Time (sum of fixation durations made in the interest are in the first reading of the interest area - this was also the early measure under investigation), Interest Area Reading Time (sum of all fixation durations in the area of interest) and Interest Area Fixation Count (total number of all fixations in the interest area). Two global measures were also investigated - these were Trial Fixation Count (total number of fixations on a

sentence) and Trial Total Reading Time (total time taken for a participant to read a sentence).

The means and standard deviations were first produced for the effects of Expectedness and Naturalness on each measure. These figures are included in Table 05:

	Expected		Unexpected	
	Natural	Unnatural	Natural	Unnatural
Local (phrase-level) measures	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
IA First pass Reading Time	372.35 (297.45)	365.97 (307.56)	417.84 (326.34)	401.33 (367.80)
IA Total Reading Time	526.15 (215.96)	519.93 (232.38)	593.91 (259.68)	595.64 (286.13)
Fixation Count	2.46 (1.40)	2.45 (1.41)	2.72 (1.48)	2.71 (1.53)
Global (trial-level) measures				
Trial Reading Time	2427.53 (1028.09)	2427.67 (948.93)	2491.78 (889.88)	2499.93 (1009.55)
Trial Fixation Count	11.65 (4.76)	11.68 (4.21)	12.01 (4.12)	11.88 (4.28)

Table 05: Local (phrase-level) and global (trial-level) measures for expected vs. unexpected phrases, and for natural vs. unnatural phrases, mean values with standard deviation reported in brackets. For duration measures figures are in milliseconds (ms); fixation counts are raw counts

All continuous reading measures (Interest Area First Pass Reading Time, Interest Area Reading Time and Trial Total Reading Time) were log-transformed (base 10) to account for the right skew evident in the raw data. The discrete data sets (Interest Area Fixation Count and Trial Fixation Count) were analysed using a generalised linear model (glmer) with poisson distribution. This paper presents MCMC-estimated p-values which are considered significant at the sigma=0.05 level.

The data was analysed using the R packages lme4 (Bates, Maechler & Bolker, 2012) and lmerTest (Kuznetsova, Brockhoff & Christensen, 2019).

Linear Mixed Effects (LME) models were used for the statistical analysis of this data. In order to address the language as a fixed effect fallacy (Clark, 1973), both Subjects and Items were included as random effects (see Baayen et al., 2008). Expectedness and Naturalness were the model's fixed effects, and Frequency was included as a covariate.

The four experimental conditions were inserted in the models as two two-level treatment-coded categorical variables: Expectedness (whether or not the target word is expected following the prime word, expected = baseline) and Naturalness (whether or not this sentence was taken verbatim from a corpus, natural = baseline). Frequency (how frequent a word is in natural language) was also included to account for any variance that had not already been accounted for during the stimulus selection stage of the project.

4.1 Local Measures

IA First Pass Reading Time

The following section will explore the effects of Expectedness, Naturalness and Frequency on IA First Pass Reading Time. This measure shows how long a participant spends reading the interest area the first time, without including regressions or second readings of the interest area. The discussion will focus particularly on Expectedness as that is central to Hoey's hypothesis; Naturalness and Frequency have been primarily included to account for any unintended effects the naturalness of a phrase or the frequency of a word in the general lexicon may have.

The interaction between Expectedness and Naturalness was first explored in relation to IA First Pass Reading Time. The results of this exploration are included in Table 06:

Fixed effects:					
	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	178.85	10.08	103.34	17.75	<2e-16 ***
Effect of Expectedness	15.70	12.25	90.26	1.28	0.20
Effect of Naturalness	-2.43	12.27	90.67	-0.20	0.84
Interaction between Expectedness and Naturalness	-9.05	21.73	58.64	-0.42	0.68

Table 06: The interaction between Expectedness and Naturalness in relation to IA First Pass Reading Time

As can be seen from Table 06, the interaction between Expectedness and Naturalness is not significant (β= -9.05, t= -0.42, p= 0.68). Therefore, this interaction was excluded from further analyses in order to maintain a simple model. However, Naturalness was still included as a fixed effect in order to control for its effects.

The interaction between Frequency and the other effects was then analysed in order to determine whether any of these interactions were warranted. The results of the analysis can be seen in Table 07:

Fixed effects:					
	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	179.68	39.72	192.37	4.52	1.06e-05 ***
Effect of Expectedness	38.55	34.70	1308.28	1.11	0.27
Effect of Frequency	0.18	5.8365 1	85.45	0.03	0.98
Effect of Naturalness	-20.05	34.54	1307.51	-0.58	0.56
Interaction between Expectedness and Frequency	-4.11	5.13	1356.46	-0.80	0.42
Interaction between Naturalness and Frequency	1.96	5.10	1358.98	0.38	0.70

Table 07: The interaction between Frequency and Expectedness, and Frequency and Naturalness, in relation to IA First Pass Reading Time

The effect of Frequency as a fixed effect (β= -9.05, t= 0.03, p= 0.98), in an interaction with Expectedness (β= -4.11, t= -0.80, p= 0.42) and in an interaction with Naturalness (β= 1.96, t= 0.38, p= 0.70) are all not significant. However, as with Naturalness, the effect of Frequency was still included as a fixed effect in order to control for its effects.

The final model used to explore the effects of Expectedness, Naturalness and Frequency on IA First Pass Reading Time included the three aforementioned variables as fixed effects. The results of this model can be seen in Table 08:

Fixed effects:					
	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	184.86	31.58	91.48	5.85	7.4e-08 ***
Effect of Expectedness	11.15	5.79	1315.52	1.93	0.05
Effect of Naturalness	-7.00	5.79	1294.44	-1.21	0.23
Effect of Frequency	-0.58	4.61	83.36	-0.13	0.90

Table 08: Expectedness, Naturalness and Frequency all as fixed effects in relation to IA First Pass Reading Time

Table 08 shows a marginal significant effect for Expectedness (β= 11.15, t= 1.93, p= 0.05). The effects for Naturalness (β= -7.00, t= -1.21, p= 0.23) and Frequency (β= -0.58, t= -0.13, p= 0.90) are both not significant. The significant effect for Expectedness is shown in Figure 02:

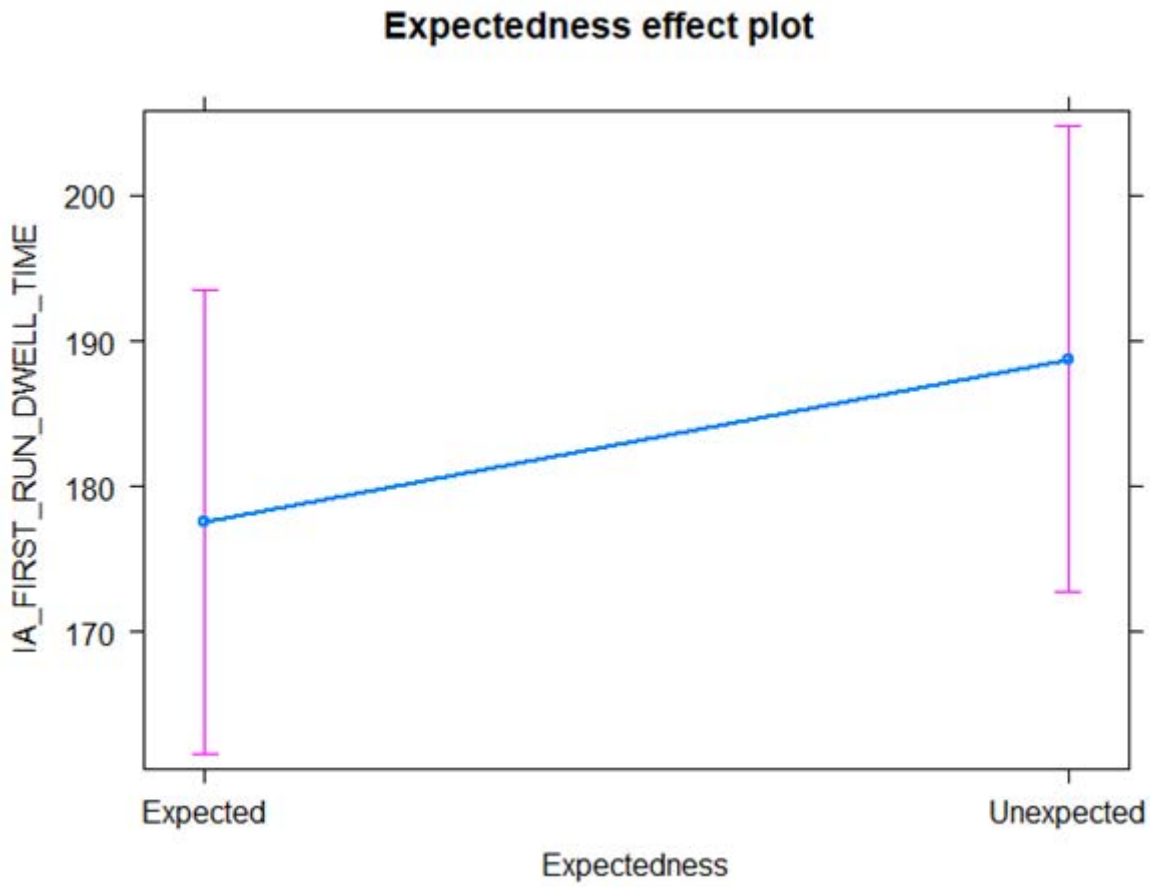

Figure 02: Effects of Expectedness on IA First Pass Reading Time

In summary, this means that when an unexpected colligatory pair is read the first time, it takes longer for a participant to read and process this phrase when compared to an expected colligatory pair.

IA Total Reading Time

This section will explore how the fixed effects Expectedness, Naturalness and Frequency affect IA Total Reading Time. IA Total Reading Time is the total time spent reading an interest area, including regressions into the interest area and second, third or further readings of the interest area.

There were two possible ways to include Expectedness and Naturalness as fixed effects in the linear mixed effects model. These are to include the interaction between them or to include them independently of each other.

The model was first run with the interaction included; the results are shown in Table 09:

Fixed effects:					
	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	6.10	0.06	93.25	94.47	<2e-16
Effect of Expectedness	0.14	0.08	75.43	1.88	0.06
Effect of Naturalness	-0.01	0.08	75.77	-0.16	0.87
Interaction between Expectedness and Naturalness	0.00	0.14	55.63	-0.03	0.98

Table 09: The interaction between Expectedness and Naturalness in relation to IA Total Reading Time

As demonstrated by Table 09, the interaction between Expectedness and Naturalness as fixed effects was not significant ($\beta < -0.001$, $t = -0.03$, $p = 0.98$). Due to this, the interaction was excluded in order to simplify the model. However, Naturalness was still included as a fixed effect in order to control for its effects.

The same steps were run to evaluate whether or not the interaction between Frequency and the other fixed effects should be included. This is shown in Table 10:

Fixed effects:					
	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	5.99	0.30	115.07	19.73	<2e-16 ***
Effect of Expectedness	0.25	0.44	113.19	0.57	0.57
Effect of Frequency	0.02	0.05	109.23	0.35	0.73
Effect of Naturalness	0.27	0.43	113.78	0.64	0.52
Interaction between Expectedness and Frequency	-0.02	0.07	112.12	-0.23	0.82
Interaction between Naturalness and Frequency	-0.04	0.06	112.43	-0.66	0.51

Table 10: The interaction between Frequency and Expectedness, and Frequency and Naturalness, in relation to IA Reading Time

As demonstrated by Table 10, the interaction between Frequency and Expectedness was not significant (β = -0.02, t= -0.23, p= 0.96), nor was the interaction between Frequency and Naturalness (β = -0.04, t= -0.66, p= 0.51). Both interactions were therefore excluded in order to simplify the model. Frequency was still included as a fixed effect in order to control for its effects, even though this model shows its effect to be not significant (β= 0.02, t= 0.35, p= 0.73).

Following these queries and eliminations, the final model which was used to explore the effect of Expectedness on IA Total Reading Time is as follows - Expectedness, Naturalness and Frequency were all included as independent

fixed effects. The answer to the question of whether each of the fixed effects made a significant difference on IA Total Reading Time can be found in Table 11:

Fixed effects:					
	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	6.19	0.19	105.36	32.33	< 2e-16 ***
Effect of Expectedness	0.14	0.03	1371.43	4.63	3.96e-06 ***
Effect of Naturalness	-0.02	0.03	1352.97	-0.52	0.61
Effect of Frequency	-0.01	0.03	96.39	-0.51	0.61

Table 11: Expectedness, Naturalness and Frequency all as fixed effects in relation to IA Total Reading Time

As can be seen from Table 11, the effect of Expectedness on IA Total Reading Time was significant (β= 0.14, t= 4.63, p< 0.001). The effects of Naturalness (β= -0.02, t= -0.52, p=0.61) and Frequency (β= -0.01, t= -0.501, p=0.61) were not significant. The effect of Expectedness is shown in Figure 03:

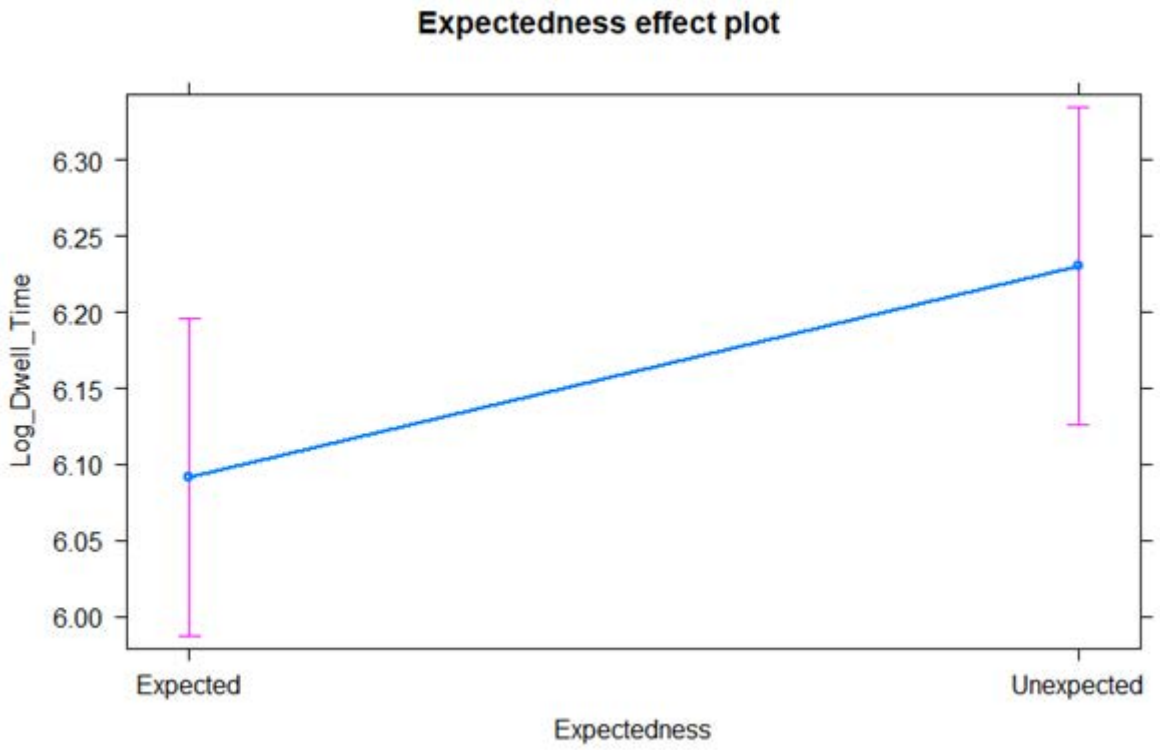

Figure 03: Effects of Expectedness on IA Reading Time

In summary, the model run shows that when a colligation is unexpected, time spent reading the colligatory pair increases compared to when an expected pair is read.

IA Fixation Count

This section will explore how the fixed effects Expectedness, Naturalness and Frequency affect IA Fixation Count. IA Fixation Count is the number of times a participant focuses on the interest area throughout a trial.

The interaction between Expectedness and Naturalness in terms of IA Fixation count was explored. The results are included in Table 12:

Fixed effects:				
	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.84	0.06	13.26	<2e-16 ***
Effect of Expectedness	0.13	0.08	1.65	0.10
Effect of Naturalness	0.01	0.08	0.15	0.88
Interaction between Expectedness and Naturalness	-0.01	0.14	-0.05	0.96

Table 12: The interaction between Expectedness and Naturalness in relation to IA Fixation Count

As can be seen from Table 12, the interaction between Expectedness and Naturalness is not significant (β= -0.01, z= -0.05, p= 0.96). As such, this interaction can be disregarded in order to simplify the model. Naturalness was still included as a fixed effect, however, in order to control for its effects. The effect of Frequency was then explored for its interactions with Expectedness and Naturalness. The results of this investigation are included in Table 13:

Fixed effects:					
	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	5.99	0.30	115.07	19.73	<2e-16 ***
Effect of Expectedness	0.25	0.44	113.19	0.57	0.57
Effect of Frequency	0.02	0.05	109.23	0.35	0.73
Effect of Naturalness	0.27	0.43	113.78	0.64	0.52
Interaction between Expectedness and Frequency	-0.02	0.07	112.12	-0.23	0.82
Interaction between Naturalness and Frequency	-0.04	0.06	112.43	-0.66	0.51

Table 13: The interaction between Frequency and Expectedness, and Frequency and Naturalness, in relation to IA Fixation Count

As can be seen in Table 13, the interactions between Frequency and Expectedness (β= -0.02, z= -0.23, p= 0.812) and Frequency and Naturalness (β= -0.04, z= -0.66, p= 0.51) are both not significant. The effect of Frequency as a fixed effect is also not significant (β= 0.02, z= 0.35, p= 0.73). However, as before, it will continue to be included as an independent variable in order to control for its effects. Due to these summaries, the model chosen for the analysis, much like the previous analyses, will include the three key fixed effects - Expectedness, Naturalness and Frequency - as independent variables. The answer to whether each of the fixed effects made a significant difference on IA Fixation Count can be seen in Table 14:

Fixed effects:				
	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.92	0.20	4.57	4.83e-06 ***
Effect of Expectedness	0.12	0.04	3.35	0.000811 ***
Effect of Naturalness	0.01	0.04	0.19	0.85
Effect of Frequency	-0.01	0.03	-0.42	0.68

Table 14: Expectedness, Naturalness and Frequency all as fixed effects in relation to IA Fixation Count

As can be seen from Table 14, the effect of Expectedness on IA Fixation Count was significant (β= 0.12, z= 3.35, p< 0.001). The effects of Naturalness (β= 0.01, z= 0.19, p= 0.85) and Frequency (β= -0.01, z= -0.42, p= 0.68) were not significant. The significant effect of Expectedness is demonstrated visually in Figure 04:

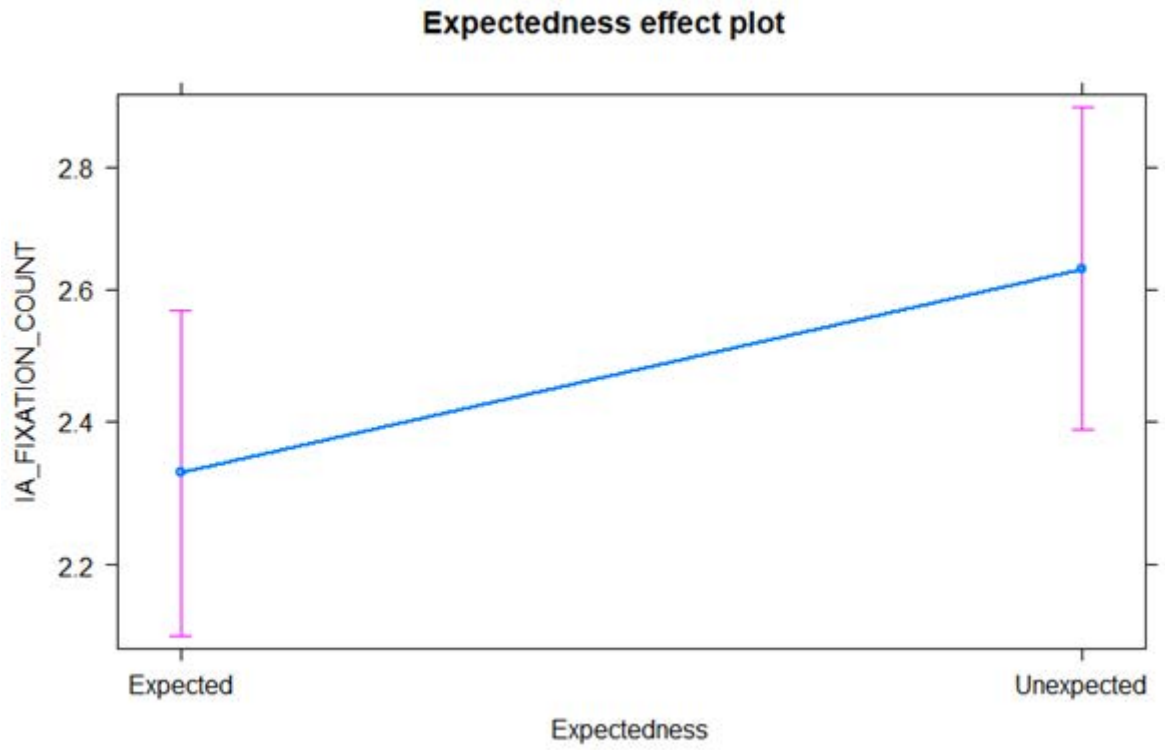

Figure 04: Effects of Expectedness on IA Fixation Count

In summary, the model shows that when a colligation is unexpected, the number of times a participant's gaze will focus on the colligatory pair increases significantly compared to when an expected pair is read. This further supports Hoey's claim that synonyms do not share colligatory preferences and aligns with the findings of the previous analyses.

4.2 Global Measures

Trial Total Reading Time

This section will explore how the fixed effects Expectedness, Naturalness and Frequency affect Trial Total Reading Time. This global measure will first be explored for the interaction between Expectedness and Naturalness, and then for the interaction of Frequency with the other two fixed effects. The results of the model which explored the interaction between Expectedness and Naturalness can be found in Table 15:

Fixed effects:					
	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	7.71	0.05	48.64	170.44	<2e-16 ***
Effect of Expectedness	0.04	0.03	80.18	1.38	0.17
Effect of Naturalness	0.01	0.03	80.53	0.39	0.70
Interaction between Expectedness and Naturalness	-0.02	0.06	56.01	-0.31	0.76

Table 15: The interaction between Expectedness and Naturalness in relation to Trial Total Reading Time

As can be seen from Table 15, the effect of the interaction was not significant (β= -0.02, t=-0.31, p= 0.76). Therefore, the interaction will be excluded from the final analysis. Naturalness was still included as a fixed effect, however, in order to control for its effects. The effect of Frequency - as a fixed effect, and in interactions with Expectedness and Naturalness - was then explored, the results of which can be seen in Table 16:

Fixed effects:					
	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	7.73	0.14	126.58	56.75	<2e-16 ***
Effect of Expectedness	-0.05	0.19	109.54	-0.25	0.80
Effect of Frequency	0.00	0.02	106.88	-0.17	0.86
Effect of Naturalness	0.09	0.19	109.75	0.46	0.65
Interaction between Expectedness and Frequency	0.01	0.03	107.88	0.52	0.61
Interaction between Naturalness and Frequency	-0.01	0.03	107.93	-0.37	0.72

Table 16: The interaction between Frequency and Expectedness, and Frequency and Naturalness, in relation to Trial Reading Time

As before, the effect of Frequency as a fixed effect was not significant (β= -0.00, t= -0.17, p= 0.86). The interactions between Expectedness and Frequency (β= 0.02, t= 0.52, p= 0.61) and Naturalness and Frequency (β= -0.01, t= -0.37, p= 0.72) are also not significant. As before, the effect of Frequency will still be included to control for its effects. This led to the decision to include Expectedness, Naturalness and Frequency as independent variables in the final model.

The answer to whether each of the fixed effects made a significant difference on Trial Total Reading Time can be seen in Table 17:

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	7.80	0.09	117.20	86.07	<2e-16 ***
Effect of Expectedness	0.03	0.01	1344.00	2.49	0.01 *
Effect of Naturalness	0.00	0.01	1322.00	0.17	0.87
Effect of Frequency	-0.01	0.01	88.26	-1.07	0.29

Table 17: Expectedness, Naturalness and Frequency all as fixed effects in relation to Trial Reading Time

As can be seen from Table 17, the effect of Expectedness on Trial Total Reading Time was significant (β= 0.03, t= 2.49, p= 0.01). The effects of Naturalness (β= 2.36e-03, t= 0.17, p=0.87) and Frequency (β= -0.01, t= -1.07, p=0.29) were not significant. The significant effect of Expectedness is demonstrated visually in Figure 05:

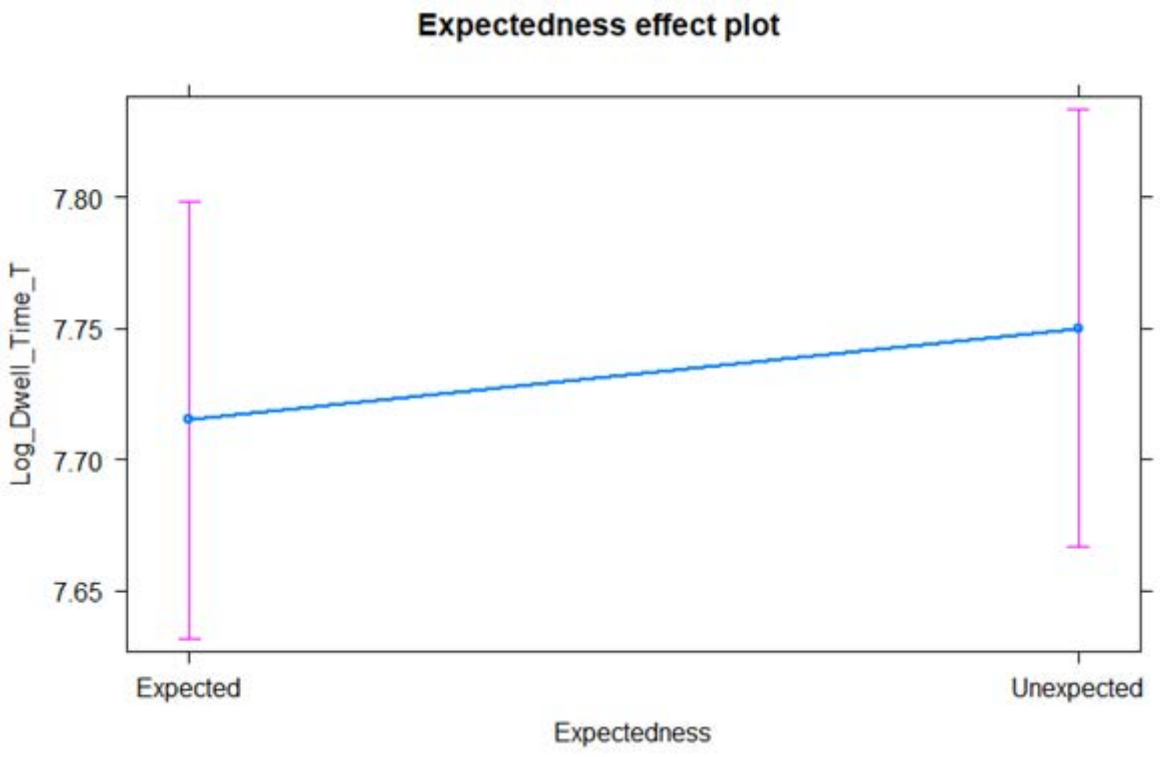

Figure 05: Effects of Expectedness on Trial Total Reading Time

In summary, the model shows that when a colligatory pair is unexpected, total time spent reading a trial which includes an unexpected pair increases compared to when an expected pair is read. This further supports Hoey's claim that synonyms will differ in terms of their colligatory preferences and aligns with the findings of the previous analyses.

Trial Fixation Count

This section will explore how the fixed effects Expectedness, Naturalness and Frequency affect Trial Fixation Count. As before, the interactions between the three key fixed effects will first be explored, in order to establish whether the interactions should be included in the final analysis.

The interaction between Expectedness and Naturalness was first investigated. The results of the investigation are included in Table 18:

Fixed effects:				
	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	2.41	0.04	60.37	<2e-16 ***
Effect of Expectedness	0.04	0.03	1.34	0.18
Effect of Naturalness	0.02	0.03	0.55	0.58
Interaction between Expectedness and Naturalness	-0.03	0.06	-0.57	0.57

Table 18: The interaction between Expectedness and Naturalness in relation to Trial Fixation Count

The interaction between Expectedness and Naturalness is not significant (β= -0.03, z= -0.57, p=0.57); the interaction will be excluded in the following analyses. However, Naturalness was still included as a fixed effect in order to control for its effects. The impact of Frequency on Trial Total Reading Time - as a fixed effect and in interactions with Expectedness and Naturalness - was then explored - the results are included in Table 19:

Fixed effects:				
	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	2.41	0.14	17.23	<2e-16 ***
Effect of Expectedness	0.00	0.19	0.00	1.00
Effect of Frequency	0.00	0.02	-0.01	0.99
Effect of Naturalness	0.15	0.19	0.77	0.44
Interaction between Expectedness and Frequency	0.01	0.03	0.24	0.81
Interaction between Naturalness and Frequency	-0.02	0.03	-0.67	0.51

Table 19: The interaction between Frequency and Expectedness, and Frequency and Naturalness, in relation to Trial Fixation Count

The effect of Frequency (β= -0.00, z= -0.01, p= 0.99), its interaction with Expectedness (β= 0.01, z= 0.24, p= 0.81) and its interaction with Naturalness (β= -0.02, z= -0.67, p= 0.51) are all not significant. As before, Frequency will

continue to be included as an independent fixed effect in order to control for its effects.

The answer to whether each of the fixed effects - Expectedness, Naturalness and Frequency - had a significant effect on Trial Fixation Count can be found in Table 20:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	2.50	0.09	28.16	<2e-16 ***
Effect of Expectedness	0.03	0.02	1.56	0.12
Effect of Naturalness	0.00	0.02	0.05	0.96
Effect of Frequency	-0.01	0.01	-1.04	0.30

Table 20: Expectedness, Naturalness and Frequency all as fixed effects in relation to Trial Fixation Count

As can be seen from Table 20, the effect of Expectedness on Trial Fixation Count was not significant (β= 0.03, z= 1.56, p=0.12). The effects of Naturalness (β= 0.00, z= 0.05, p=0.96) and Frequency (β= -0.01, z= -1.04, p=0.30) were also not significant. The lack of effect of Expectedness on Trial Fixation Count can be seen in Figure 06:

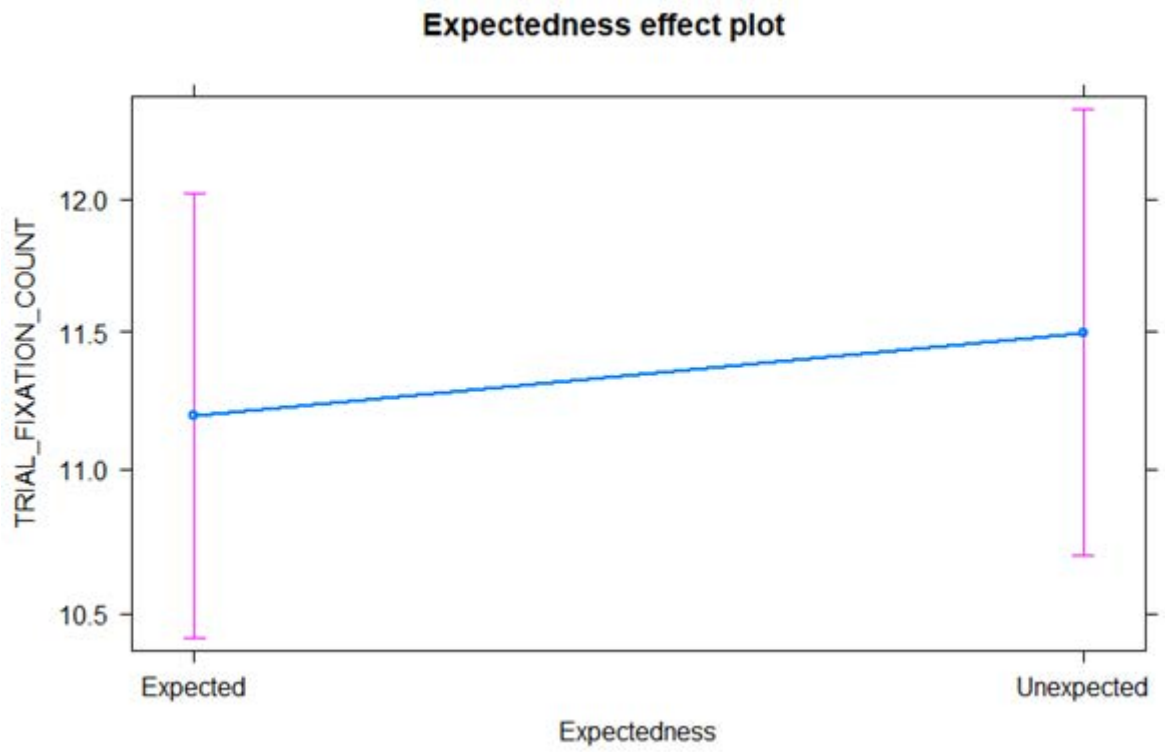

Figure 06: Effects of Expectedness on Trial Fixation Count

In summary, the model shows there is no significant difference in the number of fixations a participant makes during the trial whether there is an expected or unexpected colligatory pair in the sentence. This does not support Hoey's claim that synonyms will differ in terms of their colligatory preferences, and contrasts with the findings of the previous analyses. The results are able to contribute to not only the validity of the psychological reality of synonyms having different colligatory preferences, but also many other, broader queries.

CHAPTER FIVE: DISCUSSION

The results of the study reported in the previous chapter will now be explored in further detail. They will be primarily explored for their impact on Hoey's claim that synonyms will differ in terms of their colligatory preferences. They will further be investigated for what the results mean in terms of the broader set of approaches to language categorised as phraseological. Due to the difference in the nature of the results of analyses of local and global measure analyses, it is also important to consider why this may have been the case. As touched upon in the previous review of the surrounding literature, the results of this study may also contribute to the contemporary discussion on synonymy. Although not the focus of this study, it is still worth exploring how these results may impact the defining and categorisation of synonyms and near-synonyms.

5.1 Local Measures

As demonstrated in the results section, all three of the local measures investigated returned significant effects for Expectedness. The fact that all three of these local measures show significant effects for Expectedness is interesting and gives rise to further queries about the processing of the stimuli. The results of this project indicate that Expectedness has a significant effect on local measures results wherein when a colligatory pair was Expected it was processed significantly faster than when a colligatory pair was Unexpected. The following discussion will explore the details of this claim. These implications will be discussed alongside the impact of the results of global measure analyses following the next section of the report,

which will break down the individual global measure results and what they mean.

IA First Pass Reading Time

The results of the analysis of the IA First Pass Reading Time measure showed a significant effect for Expectedness on IA Total Reading Time. The direction of this effect indicates that when a phrase is Unexpected, a reader will take significantly more time reading it than its Expected counterpart when reading the interest area for the first time. To detail this with an example:

Sentence, Expected

It was an [**excellent rehearsal**] and the teacher was delighted.

Sentence, Unexpected

It was a [**valuable rehearsal**] and the teacher was delighted.

In the above example, the phrase “excellent rehearsal” was Expected based on the colligatory patterns of “excellent” in the British National Corpus. “Valuable rehearsal” was Unexpected based on its own patterns. In this example, the phrase “valuable rehearsal” would have taken more time to read than “excellent rehearsal”, when based solely on the first run of the participant’s gaze. The results of early measure analyses are argued to be indicative of the initial effort required to recognise the word or phrase, and to access that word or phrase in the mental lexicon (Inhoff, 1984; Altarriba et al., 1996; Paterson, Liversedge & Underwood, 1999; Conklin, Pellicer-Sánchez & Carrol, 2018). The significance and direction of the effect of

Expectedness on this early measure indicates difficulty with this first stage of reading when a pair is Unexpected. Priming effects present through early measures are automatic - they occur without any knowledge of context from the participant (Pawley & Syder, 1975a, 1975b). A significant delay in the recognition or accessing of the phrase in question when a variable is manipulated indicates that the variable plays a large part in the initial recognition or accessing of natural reading.

IA Total Reading Time

The results of this analysis of the IA Total Reading Time measure showed a significant difference for Expectedness on IA Total Reading Time. The direction of this effect indicates that when a phrase is Unexpected, a reader will take significantly more time to process than its Expected counterpart. To detail this with an example:

Sentence, Expected

All these reasons were found [**excellent by**] the judge.

Sentence, Unexpected

All these reasons were found [**wonderful by**] the judge.

In the above example, the phrase “excellent by” is Expected, based on the colligatory patterns of “excellent” and its synonyms found in the patterns of language in the British National Corpus. “Wonderful by” is Unexpected, based on its own patterns. Based on the results of the IA Total Reading Time analysis, the phrase “excellent by” will have taken less time to read by

participants overall, compared to the phrase “wonderful by”. This is based on IA First Pass Reading Time combined with any consequent regressions or returns into the interest area for it to be read again, resulting in total IA Total Reading Time. The difference between the time spent reading the interest area for the first time and in total can be explained by two key movements of gaze. The first is regressions, or reversions directly back into the interest area once the interest area has already been passed once. The second movement is multiple runs, where a participant reads the full sentence more than once rather than just the interest area more than once. A regression may be indicative of difficulty understanding the interest area, whereas a second or third run may indicate difficulty integrating the interest area into the rest of the trial (Rayner, Slattery & Belanger, 2010). The results of interest area level late measure analyses are indicative of a later stage of processing than interest area level early measures analyses (Inhoff, 1984; Altarriba et al., 1996; Paterson, Liversedge & Underwood, 1999; Conklin, Pellicer-Sánchez & Carrol, 2018). This later stage typically involves integration of the meaning of the interest area. The implications of this significant effect of Expectedness on IA Total Reading Time are that Expectedness has a significant effect on the later processing stages.

IA Fixation Count

The results of the analysis of the IA Fixation Count measure showed a significant effect of Expectedness. The direction of this effect means is that when an interest area is Unexpected there are significantly more separate

fixations on the interest area, regardless of the fixation duration. To illustrate this clearly with an example:

Sentence, Expected

Extra care is [**essential to**] get professional-looking results.

Sentence, Unexpected

Extra care is [**crucial to**] get professional-looking results.

In the above example, “essential to” is to be Expected based on the colligatory patterns of “essential” according to the British National Corpus. “Crucial to” is Unexpected based on its own patterns. According to the results of the IA Fixation Count analysis, the phrase “crucial to” would have been fixated on more frequently than its counterpart, “essential to”. Fixation counts provide an alternative way of exploring attention paid to an interest area or trial (Conklin, Pellicer-Sánchez & Carrol, 2018). This higher fixation count is indicative of difficulty recognising and accessing the meaning of the Unexpected phrase in the interest area.

5.2 Global Measures

The results of this project were also interesting in terms of the analyses of global measures. As was discussed in the literature review of this project, global measures are said to be indicative of the mental effort required to understand a whole text. Global measures tell us about the overall process of understanding a piece of text. It the context of this study, and in conjunction with the knowledge collected from the local measures, they can be used to

show how much of an impact the processing effort required to read the interest area has on the processing of the rest of a text.

Trial Total Reading Time

The results of the Trial Total Reading Time measure analysis showed a marginally significant effect of Expectedness on Trial Total Reading Time where, if a pair was Expected, a sentence took marginally less time to be processed than if the pair was Unexpected. What this means can be well illustrated by the below example:

Sentence, Expected

[This can be especially **challenging for** people in urban areas.]

Sentence, Unexpected

[This can be especially **troublesome for** people in urban areas.]

In the above example, the phrase “challenging for” is Expected based on the colligatory patterns of “challenging”. “Troublesome for” is Unexpected based on its own patterns. Even though the rest of the sentence remains unchanged, the effect of Expectedness on just the interest area meant that the overall time spent reading the sentence which contained the Expected phrase was significantly lower than the overall time spent reading the sentence which contained the Unexpected phrase. This is indicative of an overall difficulty reading and processing the whole trial when the embedded colligatory pair was Unexpected. However, the fact that this difference in

processing time was only marginal means that the effect of the manipulation of the interest area on the processing time of the whole trial was limited.

Trial Fixation Count

The results of the Trial Fixation Count measures analysis showed no significant effect for any of the variables. This is particularly of note in terms of the effect of Expectedness as each of the other measures under investigation returned significant effects for Expectedness. In terms of Expectedness, this means that whether a phrase was Expected or Unexpected had no significant effect on the number of fixations a participant made on a sentence when reading. To illustrate this more clearly with an example:

Sentence, Expected

[The temptation for me to return to safety was **massive.**]

Sentence, Unexpected

[The temptation for me to return to safety was **enormous.**]

In the example above, “massive” was to be Expected, based on the colligatory patterns of “massive” in the British National Corpus. “Enormous” was Unexpected, based on its own patterns in the corpus. According to the results of the Trial Fixation Count measure analysis, despite this difference in levels of Expectedness, the number of fixations made on average by participants would not have differed significantly between these two sentences. This is regardless of the significant effect Expectedness did have

on the IA Fixation Count measure. Fixation counts provide an alternative way of exploring attention paid to an interest area or trial (Conklin, Pellicer-Sánchez & Carrol, 2018). This result, in conjunction with the marginal result of the Trial Total Reading Time measure, further indicates that the effect of the manipulation of the interest area on total processing measures is limited.

5.3 Implications

Based on the results of the preliminary analysis used to curate the stimuli for this project, synonyms do have different colligatory preferences. The validity and strength of these colligatory preferences were tested in this project. These results were able to provide statistical evidence in support of Hoey's claim that synonyms differ in terms of their colligatory preferences. They show that synonyms have different colligations despite the lack of difference in meaning. This conclusion is based on the assumption that if a colligatory pair takes less time to read, it has taken less time to be accessed in the mental lexicon and processed. This is indicative of a lack of difficulty in processing the colligatory pair - Hoey attributes this lack of difficulty to familiarity with the phrase in its colligatory pattern. Although this is just one element of Hoey's theory, it is - to this researcher's knowledge - the first piece of psycholinguistic evidence specifically collected in order to validate any part of Hoey's theory. Hopefully this will open the gates to further explorations of the other tenets of Hoey's hypothesis in the future.

Not only do these results provide an insight into the validity of an element of Hoey's theory, they can also weigh in on the ongoing discussion of different types of synonyms. As has been touched on previously, it has been said that

true synonyms, also known as absolute synonyms (Cruse, 2000), are able to be substituted for one another - in any contexts in which their common sense is denoted - with no change to truth-value, communicative effect or meaning (Yuliawati & Indira, 2019). Due to this high standard of categorisation, absolute synonyms are rare (Edmonds & Hirst, 2002). In terms of this research project, no specific type of synonym relationship was specified - rather, the fact that absolute synonyms were rare was acknowledged, and the definition was expanded to include the broader term similonym (Bawcom, 2003). The results of this study have been able to provide some interesting empirical evidence to contribute to the discussion surrounding synonymy. The results of this study show that the synonyms used cannot be substituted for one another in any context. This is shown by the difference in processing times for synonyms in each other's places. What these results mean for the discussion surrounding synonymy is that these alleged synonyms do behave differently in terms of their colligational preferences - and, at least on a subconscious level, native speakers are aware of this. This supports the claim that absolute synonyms are rare and near synonyms, or similonyms, can differ in ways as subtle as their colligatory preferences. This has implications for Hoey's (2005) 'naturalness' concept - native speakers, as shown by the results of this analysis, have some knowledge of these minute differences and as such can take them into account when choosing words from their mental lexicon, even between synonyms.

The preferences of the synonyms explored and the effect these preferences had on processing times show results worthy of discussion. The results of this project show an interesting pattern when comparing the results of the

local measure analyses and the global measure analyses, as well as analyses of early and late measures. The results of the three local measure analyses - one of which, IA First Pass Reading Time, was an early measure - all showed significant results which supported Hoey's claim that synonyms differ in terms of their colligatory preferences. In contrast, of the two global measure analyses - both of which were late measures - one result was not statistically significant, and the other result was marginally significant. This has interesting implications for Hoey's claim that synonyms differ in terms of their colligatory preferences. Analyses of early measures and late measures returning different results is a phenomenon which has been discussed in previous literature (Tomasello, 2003; Sonbul, 2015). As has been previously discussed, Sonbul (2015) postulated, in alignment with usage-based theories of language, that:

"upon encountering an unattested (non-collocate) pair ... during reading, the language user ... will intuitively respond by spending some time to try to tackle the unnaturalness. However, given the fact that collocations are composed of two open-class lemmas filling in slots in a common abstract pattern/"schema" [...] language users will quickly cope with the abnormality" (Sonbul, 2015:432)

Although referring directly to collocations, this suggestion could easily be applied to colligations as they represent a similar type of preference-based relationship between words. What this means in terms of the results of this project is that it is reasonable to suggest that participants had difficulty with the initial recognition of an Unexpected colligatory pair. This manifested in

the results of the early measure analysis, in this case a significant result for longer IA First Pass Reading Time when a pair was Unexpected. However, upon realisation that the Unexpected pair is grammatically sensical and can be understood, the Unexpected pair's impact on the processing of the rest of the text decreases, sometimes to a level where it is insignificant, in this case a result for trial fixation count which was not significant.

Based on the results of the early measure analysis, these results support the claim that phrasal priming effects function at the automatic level, due to the presence of a priming effect in the early measure analyses (Neely, 1977; den Heyer et al., 1983; de Groot, 1984). This is a claim which has been made before through investigations into collocations through a variety of psycholinguistic measures, particularly through lexical decision tasks (McKoon & Ratcliff, 1992; Hodgson, 1991; Williams, 1996; Ellis et al., 2009; Durrant & Doherty, 2010). Through investigations as to whether phrasal or collocational priming effects are present at short Stimulus Onset Asynchronies (SOAs), these lexical decision tasks were able to provide evidence to support the claim that collocational priming functioned at the automatic level. This effect has also been explored through eye tracking tasks - if priming effects are present in early measure analyses, this is likely evidence of automatic rather than strategic priming effects (Inhoff, 1984; Altarriba et al., 1996; Paterson, Liversedge & Underwood, 1999; Conklin, Pellicer-Sánchez & Carrol, 2018).

Previous eye tracking studies have also been able to provide robust effects on reading time for the frequency with which a phrase occurs in natural

language (e.g. Yi, Lu & Ma, 2017; Siyanova-Chanturia, Conklin & Van Heuven, 2011; Sonbul, 2015). Similarly, the results of this study show a robust effect for the frequency with which colligatory pairs occur together in natural language - here referred to as level of Expectedness - where if the pair were Expected, both the pair and the sentence in which they were embedded were consistently read and processed faster. A synonym occurring in a colligatory pattern in which it frequently occurs in natural language is said here to be Expected. Studies which have explored a similar phenomenon are those which have investigated the effect of phrasal frequency - the frequency with which a set phrase occurs in natural language - investigating the robustness of the effect of collocational preferences, rather than colligatory preferences as has been explored here (Yi, Lu & Ma, 2017; Siyanova-Chanturia, Conklin & Schmitt, 2011; Valsecchi et al., 2013; Choi, 2017). The results of this investigation into colligatory preferences extends the results which have come before exploring collocatory preferences of lexical items, forming phrases, to colligatory preferences. Not only do readers appear to be sensitive to strong collocatory preferences of lexical items - they appear to show a similar sensitivity to strong colligatory preferences.

One variable which has been explored psycholinguistically in the past to investigate how a grammatical change will affect recognition and processing speeds has been the effect of word order on the recognition and processing of binomials (Siyanova-Chanturia, Conklin & Van Heuven, 2011; Conklin and Carrol, 2016). These eye tracking studies investigated the effect of word order on binomial sequences as some binomials will have a preferred order, based on corpus data - e.g. *salt and pepper* over *pepper and salt*. Although

the semantic content of the phrase remains unchanged, this alteration to the grammatical order of the words has been shown to have an effect on word recognition and processing times whereby is a binomial is presented in its reversed form, it takes longer to be processed. The results of this investigation into the colligatory preferences of synonyms demonstrate that, when manipulated, the grammatical preferences held by a lexical item can affect the processing of a lexical item or phrase. This aligns with the results of the aforementioned eye tracking studies in that grammatical preferences held by lexical items must be in some way stored in the mental lexicon so that, when the lexical items are accessed, these preferences are accessed also.

This all supports the claim which is coming to the forefront in the field of phraseology which is not just that language is highly phraseological, but that this is reflected in the organisation of the mental lexicon (Wray & Perkins, 2000; Bybee, 2006a, 2006b). The results support the claim that information about the types of lexical item with which a focal lexical item prefers to occur, according to their grammatical categories, must be stored with the lexical item in the mental lexicon. This creates links between lexical items and these links are activated when the lexical item is accessed in the mental lexicon. Not only has this investigation into synonyms and their preferences been able to contribute to the discussion surrounding lexical priming, as well as phrasal frequency, it can also contribute to the discussion around traditional priming. The results of this study have provided evidence that the presence of one lexical item will speed up the recognition of another. Regardless of the relationship between the prime and target which has caused this effect, the

result remains the same and is the basis of traditional priming theories (e.g. Collins & Loftus, 1975; Hutchison, 2003).

The results of this study have been able to provide evidence to support Hoey's claim that synonyms differ in terms of their colligatory preferences. More widely speaking, the results are also able to support the psychological reality of the existence of colligatory preferences in general. This supports the claim that information about the preferences of lexical items is stored in the mental lexicon. Lexical items are not stored in isolation but are instead stored with links to other lexical items with which they occur frequently. This supports the central tenet of phraseological approaches to language - that language is constructed of semi-predetermined phrases, information about which is stored in the mental lexicon and accessed whenever language is experienced or produced.

CHAPTER SIX: CONCLUSIONS

The aims of this project were to investigate whether eye tracking data support the psychological validity of synonyms having different colligatory preferences. The question of whether this effect would be present in both local and global measures was also investigated. The results of this study overall support Hoey's claim. The results show a significant effect of Expectedness on four of five of measures explored, where if a sentence was Expected it took less time and/or fewer fixations to process than if a sentence was Unexpected. This includes a significant effect of Expectedness on Interest Area First Pass Reading Time, Interest Area Reading Time, Interest Area Fixation Count and Trial Total Reading Time. Although there was not a significant effect for Trial Fixation Count, this should not detract from the implications of the majority of the results.

On the basis of these findings, it would be tempting to conclude firmly that the study has identified clear colligatory preferences for each of the stimulus words investigated here. However, the current study does not allow such a claim to be made, as it has only looked at synonyms in one grammatical pattern. To really test this hypothesis, it will be necessary to broaden out the focus and methodology of the current study by looking comparatively at the synonyms in different grammatical patterns, to see whether preferences across patterns can be identified. For example, rather than comparing how quickly *excellent* and *wonderful* are processed in the grammatical pattern DET ADJ NOUN, it would be of benefit to compare how quickly the lexical item *excellent* is processed in the grammatical pattern DET ADJ NOUN rather than in the grammatical pattern ADJ THAT. This is a process which

could be investigated in future work on Hoey's lexical priming theory. What the current study can claim, however, is to have provided clear evidence that for a given grammatical pattern, synonyms are not equivalent in how they are read. This is an important observation in its own right as it provides clear empirical support for Hoey's claim that synonyms do differ in how they are stored and processed in the mental lexicon, with regards to the information stored with them.

In order to not risk over-generalising these results, the claim that synonyms differ in terms of the information stored about them in the mental lexicon is the only claim that has been supported here. However, the fact that the results do support this element of the theory may indicate that there is some psychological reality to the other claims which compose lexical priming. This project certainly suggests that the other elements of this theory would benefit from an empirical investigation. Although the results of this investigation have given rise to some results which are both significant and interesting, there are certainly more ways in which work could and should be done in this area. The following section will suggest some further work which could enrich this area of research. For example, the other elements of Hoey's work could all be analysed through eye tracking.

The validity of the existence of collocations could be tested in a similar way to how this study was run. It has already tested through similar eye tracking studies, as was discussed in the literature review (e.g. Sonbul, 2015; Vilkaite, 2016). A possible way to test the hypothesis concerning semantic sets would be to take some established semantic sets in their structures - such as the

Bill Bryson sentence “SMALL PLACE is TIME DISTANCE -by VEHICLE- from LARGER PLACE” (Hoey, 2005:8) - and fill the ‘slots’ with infrequent members of the semantic sets. For example: “Birtsmorton is a two-day hike on foot from Nottingham”. The way this would be tested for its validity as a prime would be through a comparative study using the same sentence structures, some with frequent members of the semantic sets, and some with infrequent members, to see if there is a significant difference in reading time. It may also be useful to incorporate an evaluative question into this task - such as “How natural is the following sentence?” - as eye tracking measures may be affected by the frequency of the members of the semantic sets. The pragmatic association hypothesis could be tested using eye-tracking through similar strategies as semantic associations - for example, placing a lexical item in a pragmatic environment in which it is primed to occur and one in which it is not primed to occur.

Hoey’s claim about colligations has been looked at in great detail in this study - what wasn’t explored was his other claim at the level of grammar, grammatical categories. This hypothesis could be tested by using words as part of a grammatical category different to the one that they are primed to be a part of. There would be controls of the same words used as part of the grammatical category they are primed to belong to, as well as neutral statements. To illustrate this proposal with an example:

“I placed the lid on the coffee cup” using lid in its preferred grammatical category, noun

“You must lid the container” using lid in one of its non-preferred grammatical categories, verb

The usage of the lexical item in its non-preferred grammatical category must still make sense in context - for example, participants should be able to extrapolate from the example above that “lid the container” means “put a lid on the container”. The measures taken could compare the results of the fixation counts and reading times of the sentences in each condition to explore the effect of grammatical category preferences.

Much like the previous hypothesis, Hoey’s claim of textual semantic associations functions at the level of the text and could be investigated in a similar way. For example, if initial corpus research indicated that the term seventy held a preference for appearing in contrast relationships in a text, participants could be shown this lexical item in its preferred relationship, while another group of participants would see seventy in a textual relationship it does not hold a preference for, such as comparison or problem-solution relationships. The measures taken could compare the results of the fixation counts and reading times of the sentences in each condition to explore the strength of semantic associations.

Three of Hoey’s claims are made about priming at the level of the text. It would be interesting to take a large piece of natural text verbatim from a corpus, and then manipulate some of the words in the passage in order to investigate the claims made. For example, in order to explore textual collocations, a passage of text could be taken which repeats a key word in a certain way - for example, the place name *New York* being repeated with

synonyms such as *the Big Apple*, or repeated with itself, depending on what research dictates it is most likely to do. One set of participants could be shown the natural text, and another shown the text manipulated so the repetitions differ from what is natural. The measures taken could compare the results of the fixation counts and reading times of the sentences in each condition to explore the effect of textual collocation preferences.

Hoey's claim of textual colligations could be effectively explored through a comparison study - one set of participants would see an original newspaper article, for example, and another would see them with the textual colligations altered to be unlikely. For example, if research dictated that the names of the days of the week, i.e. Monday, Tuesday etc, had a preference for occurring in the first paragraph of a text, one group of participants would read a piece where this was the case, and another would read a piece of text where this was not. The measures taken could compare the results of the fixation counts and reading times of the sentences in each condition to explore the effect of textual colligatory preferences.

Hoey's claim that polysemous words differ in terms of their collocations, colligations and semantic preferences could present some difficulties in terms of stimuli preparation. It would be difficult to ensure that participants were interpreting the polysemous word as the meaning intended for the purposes of the study. It would be important to make use of contexts in this case, in order to maintain control over which sense of a polysemous word a participant should expect. This claim could be investigated with a two-sentence eye tracking experiment. The first sentence would include a

polysemous word in a particular grammatical pattern; the second sentence would make it apparent that the sense of the polysemous word in play is not the one which is suggested by the first sentence. An example of this is could be:

“The defendant knew his rights.

They were the opposite of his lefts.”

The design of this experiment could be repeated and manipulated in order to investigate colligatory preferences, collocations and semantic preferences. The measures taken could compare the results of the fixation counts and reading times of the sentences in each condition to explore whether polysemous words do have different collocations, colligations and semantic preferences.

In terms of the claim which was investigated in detail, there are even further ways it could be investigated. Of course, as discussed above, the way that the claim concerning colligatory preferences could be more thoroughly investigated could be through a reversal of the roles of the synonyms and the grammatical patterns. Furthermore, it could be beneficial to include a participant judgement system where readers are asked outright “How natural does this sentence sound?”. Including a wide variety of techniques is important as each psycholinguistic technique comes with positive and negative aspects. Another example of a psycholinguistic technique which could be employed to investigate the validity of Hoey’s hypotheses is a lexical decision task. The speed with which a target word is recognised as a word rather than a nonword may can be used to explore the strength of a

colligatory relationship. Furthermore, although this project elected not to investigate the collocate and semantic association elements of the focal claim, it is possible that they could still yield some interesting results, so they too could be explored in future research.

In summary, the results of this study conclude in support of Hoey's (2005) claim as part of his lexical priming theory that synonyms will differ in terms of the colligatory information stored about them. Conclusion in support of this claim also supports the claim that the phraseological nature of language may be reflected in the mental lexicon, with lexical items being stored with information about the types of lexical items they prefer to occur with or avoid based on behaviour of the lexical item experienced in natural language usage. In relation to the broader field of usage-based language theories, these results demonstrate a significant effect for exposure to language patterns wherein if a colligatory pattern is common in natural language it will be processed faster in reading. This echoes the concept of phrasal frequency. This supports the central tenet not only of lexical priming but also of many usage-based theories of language - that frequency of exposure to natural language is one of the key influences on language usage.

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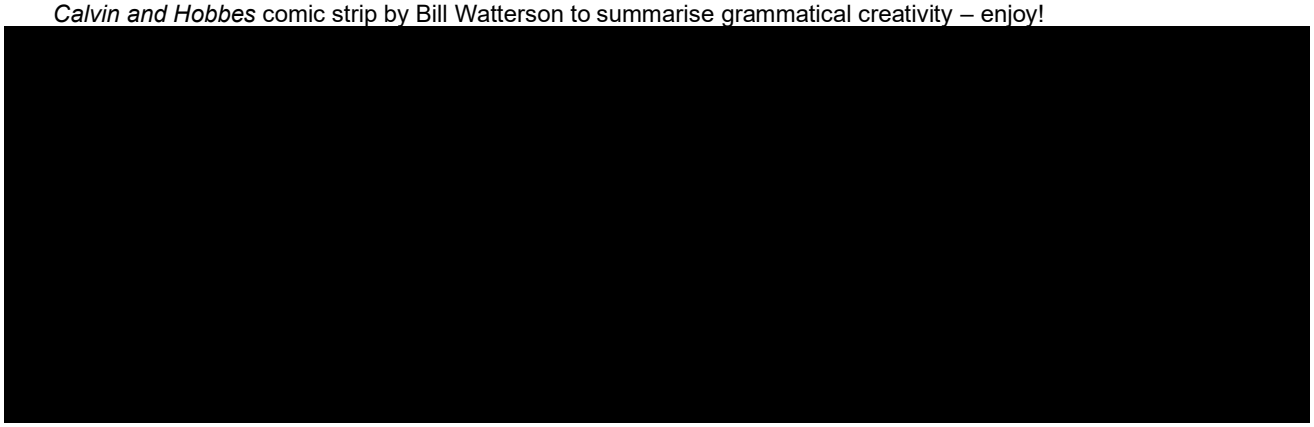
APPENDICES

Appendix 01
Calvin and Hobbes comic strip by Bill Watterson to summarise grammatical creativity – enjoy!



Appendix 02
Synonym stimuli sentences for pilot study with concordance lines referenced

Where originals are expected
Happy
ADJ N "She seems like a very **happy person**" A1X 86
She seems like a very **glad person**

V ADJ "In his student days he **was happy** and successful" A68 26
In his student days he **was cheerful** and successful

Pleased
ADJ TO-INF "I was **pleased to be** on the move again" A61 1899
I was **cheerful to be** on the move again

N V **ADJ** "The **label was pleased** with the outcome" AT1 1689
The **label was jolly** with the outcome

Glad
ADJ that "He was **glad that** there was no mirror in this room." ADA 824
He was **content that** there was no mirror in this room

V **ADJ** "I **was glad** I was born in Wales" A3X 32
I **was cheerful** I was born in Wales

Delighted
ADJ that "She was **delighted that** I was not hurt" FPV 434
She was **happy that** I was not hurt

ADJ TO-INF "I knew you'd be **delighted to hear** that" AC2 1284
I knew you'd be **ecstatic to hear** that

Content
N V ADJ "The **folk were content** and peaceful and their lives golden" CM1 267
The **folk were jolly** and peaceful and their lives golden

ADJ TO-INF "Nevertheless, they were **content to sit**, watch and wait" H90 3179
Nevertheless, they were **amused to sit**, watch and wait

Cheerful

DET ADJ “She seemed to be quite **a cheerful** old woman” AP7 679
She seemed to be quite **a content** old woman

ADJ N “He was in a **cheerful mood** and he went on with another story” BNU 2058
He was in a**n overjoyed mood** and he went on with another story

Amused
ADJ N “An **amused smile** played at the corners of his mouth” HA9 2453
A content smile played at the corners of his mouth

V **ADJ** “She **was amused** and saddened by his dilemma” BP1 1472
She **was joyous** and saddened by his dilemma

Jolly
DET ADJ “They all made **a jolly** family” ADM 1620
They all made **a content** family

ADJ N “They were a **jolly bunch** of chaps” B29 1364
They were a **thrilled bunch** of chaps

Thrilled
V ADJ “She **seemed thrilled** when I told her” A0U 498
She **seemed joyous** when I told her

N V **ADJ** “The **doctor was thrilled** with her progress” ED4 1466
The **doctor was cheerful** with her progress

Ecstatic
DET ADJ “She gave **an ecstatic** little wriggle” JYC 4468
She gave **an overjoyed** little wriggle

V ADJ “He **was ecstatic** at the response” ART 438
He **was joyous** at the response

Joyous
DET ADJ “Homecoming was **a joyous** occasion” B1Y 1243
Homecoming was **an overjoyed** occasion

ADJ N “I came to see the world as an abundant and **joyous place** to be” CA5 503
I came to see the world as an abundant and **overjoyed place** to be

Overjoyed
ADJ that “I was **overjoyed that** our letters had regained their old intimacy” AMC 700
I was **ecstatic that** our letters had regained their old intimacy

ADJ TO-INF “His father was **overjoyed to see** him” KGP 162
His father was **joyous to see** him

Where originals are unexpected
Happy
ADJ that “I'm **happy that** I've escaped to London” C8A 1794
I'm **glad that** I've escaped to London

Pleased
DET ADJ “She gave him **a pleased** earnest nod” A73 1599
She gave him **an amused** earnest nod

ADJ N “The man folded **pleased hands** across his belly” CM4 1160

The man folded **jolly hands** across his belly

Glad
DET ADJ “Air traffic confirmed **the glad** news” CLV 154
Air traffic confirmed the **joyous news**

ADJ N “For one **glad moment**, she wanted to rush to him” FPB 149
For one **happy moment**, she wanted to rush to him

Delighted
DET ADJ “The little man's face split into **a delighted** grin” HA3 345
The little man's face split into **a cheerful** grin

ADJ N “Laura gave a **delighted squeal** and flew at her sister” AN7 4114
Laura gave a **happy squeal** and flew at her sister

Content
ADJ that “Everyone was **content that** they had done their best” HP8 486
Everyone was **thrilled that** they had done their best

Cheerful
N V ADJ “The pleasant **films were cheerful** and harmless” B1J 1834
The pleasant **films were happy** and harmless

ADJ that “We were **cheerful that** summer” EDJ 779
We were **happy that** summer

Amused
ADJ that “I was **amused that** he described her in that way” B7N 1428
I was **thrilled that** he described her in that way

ADJ TO-INF “You'll be **amused to hear** that I'm fine” AMC 969
You'll be **delighted to hear** that I'm fine

Jolly
N V ADJ “Ward **meetings are jolly** occasions” HH3 9978
Ward **meetings are joyous** occasions
V ADJ “He was trying to **be jolly** again” CDY 1709
He was trying to **be content** again

Thrilled
ADJ N “I send **thrilled gibberish** to the lookout posts” APC 651
I send **cheerful gibberish** to the lookout posts

Ecstatic
ADJ TO-INF “Mother was **ecstatic to be** pregnant” H94 1725
Mother was **thrilled to be** pregnant

ADJ that “The vicar was **ecstatic that** he’d made some money”
The vicar was **overjoyed that** he’d made some money

Joyous
V ADJ “They **were joyous** because she was safe” HGD 4506
They **were ecstatic** because she was safe

ADJ TO-INF “I was **joyous to hear** a sample of the song” ACN 34
I was **overjoyed to hear** a sample of the song

Overjoyed
DET ADJ “Then **the overjoyed** youngster was swept off her feet” CH6 90
Then **the joyous** youngster was swept off her feet

ADJ N “There stood some **overjoyed neighbours** who had shared their sorrow” CH6 8245
There stood some **jolly neighbours** who had shared their sorrow

Appendix 03
First set of data for the pilot study

She seems like a very happy person
I'm glad that I've escaped to London
In his student days he was cheerful and successful
She gave him a pleased earnest nod
I was pleased to be on the move again
She gave him an amused earnest nod
The label was jolly with the outcome
The man folded pleased hands across his belly
He was glad that there was no mirror in this room
The man folded jolly hands across his belly
I was cheerful I was born in Wales
Air traffic confirmed the glad news
She was delighted that I was not hurt
For one happy moment, she wanted to rush to him
I knew you'd be ecstatic to hear that
The little man's face split into a delighted grin
The folk were content and peaceful
Laura gave a happy squeal and flew at me
Nevertheless, they were amused to sit and wait
Everyone was content that they had done their best
She seemed to be quite a cheerful old woman
The pleasant films were happy and harmless
He was in an overjoyed mood and so continued
We were cheerful that summer
An amused smile played at his mouth
I was thrilled that he described her in that way
She was joyous and saddened by his dilemma
You'll be amused to hear that I'm fine
They all made a jolly family
Ward meetings are joyous occasions
They were a thrilled bunch of chaps
He was trying to be jolly again
She seemed thrilled when I told her
I send cheerful gibberish to the lookout posts
The doctor was cheerful with her progress
Mother was ecstatic to be pregnant
She gave an ecstatic little wriggle
The vicar was overjoyed that he’d made money
He was joyous at the response
They were joyous because she was safe
Homecoming was a joyous occasion
I was overjoyed to hear a sample of the song
I saw the world as an overjoyed place to be
Then the overjoyed youngster was swept off her feet
I was overjoyed that our letters were intimate
There stood some jolly neighbours wanting to help
His father was joyous to see him
What was the chef doing while she was talking?

The resourceful doctor asked the staff to stop
Only one doctor was there that day
A survey of 282 teachers was carried out
This has a severe effect on doctor morale
He was advised by his teacher to choose the latter
I'm a teacher by profession
Though she was old she was a wonderful actress
Here was the architect coming now
No one was injured due to the nurse's actions
The inadequacy of nurse training
You may think I'm a boring actress, but guess again
We knew that his nurse was in Colorado
The lawyer's eyebrows lifted
The lawyer insisted that relations had been normal
Please can we have our lawyer back
The greatest Scottish actress of her time
They left the choice of architect up to me
This was to minimise the accountant's workload
She was a typical type of actress in the end
She had been a noted barrister in her day
There are nine actresses to see
She's married to a carpenter in Dublin now
Who were these accountants of whom they spoke?
He lived in the village as a barrister's son
There were 12 accountants given awards
She dreamed of becoming a chef at school
A new generation of dancers in Britain
They suggested that she could be our dancer
There were enquiries about the actress's life
This is a job for a skilled carpenter, alright?
Our lawyer is currently abroad

Appendix 04
Second set of data for the pilot study

She seems like a very glad person
I'm happy that I've escaped to London
In his student days he was happy and successful
She gave him an amused earnest nod
I was cheerful to be on the move again
The man folded pleased hands across his belly
The label was pleased with the outcome
Air traffic confirmed the joyous news
He was content that there was no mirror in this room
For one glad moment, she wanted to rush to him
I was glad I was born in Wales
The little man's face split into a cheerful grin
She was happy that I was not hurt
Laura gave a delighted squeal and flew at me
I knew you'd be delighted to hear that
Everyone was thrilled that they had done their best
The folk were jolly and peaceful
The pleasant films were cheerful and harmless
Nevertheless, they were content to sit and wait
We were happy that summer
She seemed to be quite a content old woman
I was amused that he described her in that way
He was in a cheerful mood and so continued

You'll be delighted to hear that I'm fine
A content smile played at his mouth
Ward meetings are jolly occasions
She was amused and saddened by his dilemma
He was trying to be content again
They all made a content family
I send thrilled gibberish to the lookout posts
They were a jolly bunch of chaps
Mother was thrilled to be pregnant
She seemed joyous when I told her
The vicar was ecstatic that he'd made money
The doctor was thrilled with her progress
They were ecstatic because she was safe
She gave an overjoyed little wriggle
I was joyous to hear a sample of the song
He was ecstatic at the response
Then the joyous youngster was swept off her feet
Homecoming was an overjoyed occasion
There stood some overjoyed neighbours wanting to help
I saw the world as a joyous place to be
I was ecstatic that our letters were intimate
His father was overjoyed to see him
What was the doctor doing while she was talking?
The resourceful lawyer asked the staff to stop
Only one actor was there that day
A survey of 282 doctors was carried out
This has a severe effect on teacher morale
He was advised by his doctor to choose the latter
I'm a nurse by profession
Though she was old she was a wonderful teacher
Here was the nurse coming now
No one was injured due to the doctor's actions
The inadequacy of lawyer training
You may think I'm a boring nurse, but guess again
We knew that his lawyer was in Colorado
The accountant's eyebrows lifted
The actor insisted that relations had been normal
Please can we have our actor back
The greatest Scottish architect of his time
They left the choice of accountant up to me
This was to minimise the chef's workload
She was a typical type of painter in the end
She had been a noted dancer in her day
There are nine architects to see
She's married to a chef in Dublin now
Who were these actresses of whom they spoke?
He lived in the village as a carpenter's son
There were 12 actors given awards
She dreamed of becoming a dancer at school
A new generation of chefs in Britain
They suggested that she could be our accountant
There were enquiries about the barrister's life
This is a job for a skilled barrister, alright?
Our carpenter is currently abroad

Appendix 05
Filler sentences

The scientist toed the line
His behaviour was a red flag
I've never considered her to be the apple of my eye
They have added insult to injury
"The ball is in your court" she sneered
I won't beat around the bush; he's guilty
He knew that I had bitten off more than I could chew
Never judge a book by its cover
Mother was furious - it would cost an arm and a leg!
The boss was really adding insult to injury with this
I sniffled, refusing to cry over spilt milk
She was desperate to find the cloud's silver lining
We gave them the benefit of the doubt
We wish the judge wouldn't beat around the bush so
The artist had hit the nail on the head
This project should kill two birds with one stone
Goodness - why wouldn't my brother live and let live?
Gran had always been a bit off her rocker
"Piece of cake, mate!" she cried, skipping away
We've never seen eye to eye on her living situation
What a way to steal my thunder…
You know she wouldn't be seen dead wearing that
Give the audience a taste of their own medicine
She was loony, barmy, absolutely off her rocker
You must notice potential red flags in relationships
She'd been told to keep an eye on the situation
An eye for an eye, a tooth for a tooth
Trust that there is a method to his madness
Can't you afford me the benefit of the doubt?
The apple of his eye was in France at the time
I wouldn't be seen dead with him
Feeling elated, I decided to call it a day and leave
"Hang in there" she reassured the sad visitor
This meeting was very quickly getting out of hand
I begged them to cut me some slack
It's not rocket science, it's just office work
Our boss was never the sharpest tool in the shed
They were cooking up a scheme together
To make matters worse, he was fired the next morning
The last straw was his attitude towards my siblings
I said "Speak of the devil" as the conductor came in
Grandma was feeling under the weather
The fisherman couldn't wrap his head around it
She didn't address the elephant in the room
The twins were like two peas in a pod
If the robbers didn't run like the wind, they'd be in trouble
We'd been together through thick and thin
You were thrown out of the frying pan and into the fire
Dad had been snowed under at work
I decided to cut the poor man some slack

Appendix 06
Consent form

Project title: Eye Tracking and Natural Reading

Researcher: Daisy Collins (Supervisors: Nick Groom / Gareth Carrol)

Purpose: The purpose of this study is to use eye tracking to explore how people read sentences. You will be asked to read a series of sentences and answer comprehension questions on them. If at any time you wish to discontinue or pause the experiment, please inform the researcher.

If you have any questions about the study, you can contact the researcher at dac517@student.bham.ac.uk.

Please read the following information and circle a response as necessary:

- I confirm that the purpose of the study has been explained and that I have understood it.
  YES/NO
- I have had the opportunity to ask questions and they have been successfully answered.
  YES/NO
- I understand that my participation in this study is voluntary and that I am free to withdraw from the study at any time, without giving a reason and without consequence. This includes the right to withdraw up to one week following completion of the study by emailing the researcher. YES/NO
- I understand that data will be collected in an identifiable form, but that it will be treated as confidential and anonymised in any research outputs.
  YES/NO
- I understand that there are no known risks or hazards associated with participating in this study.
  YES/NO
- I confirm that I do not suffer from any medical conditions (such as epilepsy, migraines or dyslexia) that might exclude me from the study. YES/NO
- I confirm that I have read and understood the above information and that I agree to participate in this study. YES/NO
- I am a native speaker of English
  YES/NO

Participant's signature: _____ Date: _____

Participant's Name (in block capitals): _____

Appendix 07

Frequencies of synonyms in each grammatical pattern

Synonym Set	Synonym	Frequency	**ADJ TO-INF**	**ADJ N**	**ADJ PREP**	**ADJ that**	**ADJ STOP**	**ADJ V**
Good	Acceptable	3373	2.4	31.9	24.5	0.2	24.8	1.1
	Valuable	3679	1.6	59.5	10.4	0.2	11.3	0.9
	Wonderful	3977	3.3	57.7	2.6	0.6	21.7	0.8
	Excellent	6029	0.1	73.6	3	0	11.2	0.3
	Positive	7475	0.3	66.7	5.3	0.3	12.1	0.6
Old	Ancient	4688	0	78.4	0.6	0	3	0.1
	Elderly	4623	0.5	64.5	3.6	0	13.5	3.9
	Mature	1445	0.2	70.4	2.2	0.1	11.7	0.3
Different	Contrasting	344	0	88.1	0.6	0	2.3	0
	Divergent	226	0.4	70.8	5.8	0.4	7.1	0
	Disparate	293	0.3	78.2	1	0	5.5	0
Possible	Achievable	176	0	30.1	23.3	0	31.3	2.3
	Conceivable	363	0.3	47.9	5.5	25.3	10.7	0.8
	Probable	165	0.6	261.2	7.3	240.6	101.2	6.7
	Viable	887	1.4	46.6	8.9	0	25.1	1.1
Large	Sizeable	456	0.2	83.3	0.4	0	2.4	0
	Gigantic	385	0.5	71.7	0.5	0	6.5	0.5
	Hefty	318	0.3	78.6	0.6	0	2.5	0.6
	Enormous	3715	0.1	74.4	0.8	0.3	11.6	0.2
	Massive	3996	0	74.1	0.6	0.1	4.3	0.3
	Vast	4398	0	79.6	0.3	0.3	5.6	0.3
Difficult	Tricky	541	**6.5**	51.9	2.8	0	18.5	1.3
	Challenging	413	0	70	3.4	0	8.7	1
	Demanding	472	0	53	7	0	13.8	0.4
	Troublesome	413	1.2	54.7	8.5	0	17.7	0.7
Simple	Facile	104	2.9	53.8	1	0	17.3	0
	Effortless	164	0.6	64	1.2	1.2	21.3	0
	Uncomplicated	173	0.6	49.1	4.6	0	19.7	0
Bad	Evil	798	0.1	61.9	2.1	0.1	15.3	0.1
	Immoral	302	**4**	30.5	8.3	0.7	36.1	1

	Vile	245	0.4	52.2	3.7	0.8	22.4	0.8
Important	Crucial	4267	1.7	58.6	18.6	1.5	9.7	0.7
	Essential	8358	**8.2**	43	19.3	6.1	13.2	0.6
	Vital	4862	**4.6**	55.6	13.6	5.7	8.9	0.5
Similar	Akin	403	3.5	0	93.3	0	1.5	0
	Alike	167	0.6	2.4	32.9	0	29.9	3.6
	Analogous	513	0.8	21.8	69.4	0	1.6	0.8
Strong	Durable	355	0	41.4	2	0.3	9	1.7
	Robust	682	1.3	48.4	4.7	0	4.7	1.5
Serious	Sincere	440	0	44.1	8.4	0.2	12.5	1.8
	Severe	442	1.6	632.8	21.5	7	36.2	10
	Austere	288	0	47.6	2.1	0	4.9	0
Dark	Dingy	131	0	65.6	1.5	0.8	4.6	0
	Murky	219	0	70.8	2.3	0	3.7	0.9
	Darkened	275	0	94.5	0	0	0	0
Cold	Chilly	290	0	52.8	6.2	0	5.9	0
	Freezing	714	0	57.3	8.1	0	6.9	0
	Frozen	882	0.2	85.5	0.2	0	0.8	0
	Icy	618	0	84.5	1.5	0.5	2.4	0
	Frosty	193	0.5	77.7	2.6	0.5	7.3	0
Successful	Prosperous	665	0.2	56.8	4.4	0.2	3.9	0.9
	Fruitful	430	3.7	55.1	8.1	0.2	9.3	2.3
	Rewarding	321	1.2	54.8	5.3	0	11.5	1.9