An Investigation into Morphological Decomposition of Suffixed Words in the Mental Lexicon

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Abstract

This paper uses experimental techniques and empirical data to support the notion that morphologically complex words are represented in terms of their individual morphemes in lexical memory. Two experiments are conducted to investigate this. The first experiment uses a semantic priming technique to investigate how semantic associations attached to specific derivational suffixes could indicate a meaning-based organisation of bound morphemes in memory. Whilst the results from Experiment One do imply a meaning based organisation for bound morphemes, there is also a possibility that this could be influenced by the surface frequency of transparent suffixed words. The second experiment therefore controls for surface frequency looking at semantically transparent words only. This rules out the possibility of participants either consciously or unconsciously using surface frequency as a means of identifying the word. Findings from Experiment Two show that high frequency stems elicit a faster response time than low frequency stems in suffixed words. This supports the notion of morphological decomposition. Overall, both experiments support the notion that bound morphemes are stored separately to whole words in memory, prior to lexical access. The implications of the two experiments are discussed in Section 4.1 with regards to what they mean for the bigger picture of morphological decomposition and the internal representation of affixes.

Author's Declaration

I declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for an award at this, or any other University. All sources are acknowledged as References.

An investigation into morphological decomposition of suffixed words in the mental lexicon

1. Introduction

1.1 Issues surrounding investigation of how derivational morphology is represented

For the meaning of morphologically complex wordsto be successfully recognised and interpreted in everyday speech, the brain must be organised in a way which allows for such understanding to be rapid, effortless and unconscious. Word and sentence comprehension take place so efficiently that whilst taking part in a conversation, one is generally unaware of the processes occurring which allow the ease and rapidity of comprehension, with word recognition taking on average around just one third of a second. Interest surrounding the neural architecture of complex words has sparked debate amongst psycholinguistic researchers, whose research focuses on lexical access and retrieval of complex words from the mental lexicon.

It is widely debated in linguistic literature whether morphologically complex words are represented and accessed in the brain in terms of their individual component morphemes, or as a whole. Taft & Forster (1975), Morris & Frank (2007), and Solomyak & Marantz (2010) reported findings to suggest that words are represented via stem word + affix, meanwhile, researchers such as Manelis & Tharp (1977) and Stanners & Nesier (1979) provided results which favour the notion of affixed words being represented in their whole form, and found little evidence to support decomposition. The literature as a whole leans more toward a kind of separation of stem + affix during the analysis of morphologically complex words, although what this means regarding their representation in the mental lexicon is still being debated.

This research discusses in detail both viewpoints to support and oppose the notion of morphologically complex words being represented in the mental lexicon in terms of their individual component morphemes, with a strong inclination toward the notion of an independent representation of stem and affix before lexical access. There is a mass of research currently existing which addresses the debate, although it is also still apparent that there exists a gap in knowledge regarding how complex words are represented in memory.

Representation of morphologically complex words is a recurring theme within a lot of linguistic research both past and present. Within the last ten years, there has been a leap in the advancement of technology used to investigate language and the brain and as a result, new research is frequently emerging incorporating techniques such as ERP and MEG brain imaging. With these scientific methods of investigating language and the brain being made accessible to psycholinguists, research is edging closer to determining how complex words are represented and analysed before lexical access. Recent research using these scientific techniques will be examined in this paper, as well as earlier research which set the groundwork on the topic of decomposition and provide a foundation for today's researchers to discuss and debate.

This paper aims to address questions such as, 'what kinds of lexical items are present within the mental lexicon?' And 'how is this information organised and stored?' These issues are addressed by focusing specifically on the recognition of bound derivational morphemes when attached to affixed words, in a series of two experiments. The first experiment identifies what role semantic associations attached to three derivational bound morphemes play in word recognition within a lexical decision task. The aim of this experiment is to investigate whether meaning is intrinsically tied to bound morphemes' representation in the mental lexicon, and what effect the meaning of bound morphemes has on complex words as a whole, both in word recognition and in their storage.

The second experiment investigates how the frequency of the root word in semantically transparent affixed words modulates the speed of word recognition in a lexical decision task. The findings related to this experiment have implications for the representation and organisation of affixed words in the mental lexicon, which is discussed in detail in Section 6.1. Both Experiment 1 and 2 aim to provide results to support the notion of morphological decomposition of affixed words before lexical access, contributing to the body of research which supports decomposition.

1.2 Semantic Priming theories

Semantic priming is the effect that subjects respond faster to words which are influenced by the word which precedes them, when both the prime and target word are related in meaning. This often involves an experiment on a computer whereby participants are required to judge words or sentences organised via PRIME-TARGET blocks. Evidence that has arisen from research incorporating the semantic priming technique suggests that the mental lexicon is organised into semantic fields. For example, research into lexical access has concluded that semantic priming is a factor which aids recognition in lexical decision tasks, which involve deciphering real words from nonsense words as quickly as possible (Meyer & Schvaneveldt, 1971). This strongly suggests a meaning based organisation of the lexicon, at least with regards to whole words. To affirm this hypothesis, there exist a number of models which have been designed to represent the mental association between words related in meaning and unrelated words. One of these is the Spreading Activation Model. The premise of this model draws a link between words which are related in meaning, with each word connected to the other, branching off into specific groups for areas of meaning. When one word is activated, the nodes which surround that word will activate other lexical items which are closely related in meaning. This allows for them to be easier to access and results in them having a higher resting activation level in the mental lexicon.

An issue of contention surrounding this theory is whether this notion of a mental mapping between words related in meaning can be generalised to morphologically complex, affixed words which carry a semantic meaning. If this is not the case, how are complex words represented and stored in lexical memory? Equally, can bound morphemes on their own which carry a specific meaning be represented in a semantic network similar to the network described in the Spreading Activation Model? The questions asked above are important for two main reasons. Firstly, the mental lexicon is comprised of various subgroups containing different types of lexical items, such as bound morphemes, compound words and both meaning and structure with a mental mapping between each. Each distinctly functioning process allows for various grammatical constructions to be created and when an area of the brain specific to one of these subgroups is damaged, the speaker is inhibited from processing these constructions. Further identifying the nature of one of the subgroups for example derivational morphemes could serve as beneficial, particularly in the case of people who have suffered brain lesions resulting in difficulty processing specific morphemes.

One benefit of identifying how and where bound morphemes are located in the lexicon is that information could be uncovered which is valuable for educational purposes. Increasing the existing knowledge regarding how the component parts of a complex word exist in memory could allow for a deeper understanding of how complex words are learnt in early years. This could have implications on how language is initially taught in schools.

In addition to this, investigating the representation of bound morphemes will contribute to the mass of research currently existing on the topic, which will further illuminate the picture of internal processing and representation as a while. Investigating bound morphemes will also provide additional insight into how morphemes are stored in lexical memory.

1.3 Preliminaries

The term mental lexicon has been cited widely in psycholinguistic papers, often with slightly varying definitions. At the least, the mental lexicon must contain a mapping between orthographic word forms, phonemic word forms and word meanings. In one case, it has been referred to as a 'permanent human dictionary in which words and their meanings are stored in the brain' (Aitchison, 1994), whilst in other research it has been referred to in a more complex sense, being used interchangeably with the term 'internal lexicon' (Bonin, 2004) to refer to the brain involving different processes and activations in order to store the words and form an 'internal memory which functions as a 'mental dictionary'. For the purpose of this paper, I will use the term mental lexicon referring to the latter statement.

Lexical access is a term used frequently in research papers concerned with morphological representation, and often the primary focus of psycholinguistic and neurolinguistic research. Lexical access typically refers to the retrieval of vocabulary from the mental lexicon. The term was originally derived from literature based around visual word recognition; however, recent literature applies the term lexical processing more freely to describe all types of word recognition. This paper uses the term 'lexical access' to describe the event whereby the whole word or individual morpheme is retrieved from the mental lexicon, dependent on which lexical item is being examined. The aim of this paper is to identify how suffixed words are represented within the mental lexicon, allowing for ease of word recognition. Therefore, investigating speed of lexical access through a lexical decision task plays a large role in determining exactly how suffixed words are being retrieved from the mental lexicon, thus providing an insight into the representation of suffixed words.

Historically in psychological and linguistic research, the speech of aphasic patients is utilized to provide an insight into dissociation between different cognitive functions, and linguistic domains. Due to the functional differences between the two classes of inflectional and derivational morphemes, it can be said that they form subgroups which function independently within the lexicon, reflecting two different types of lexical representation. (Tyler & Cobb, 1987) Tyler and Cobb (1987) studied the speech of an aphasic patient who they named (DE). Their results provided evidence to accept the notion that the processing system encompasses inflectional and derivational morphemes functioning as distinct sub components, due to DE being unable to discriminate between the two categories, in a word monitoring task. If inflectional and derivational morphemes have been shown to function independently of each other within distinct sub components, this narrows down the domains which could be viewed as independent within a potential morphological processing hub. This paper focuses solely on derivational morphemes and makes reference to the derivational morpheme space in the brain as separate to the inflectional hub.

2. Review of Relevant Literature

2.1 Representation of morphemes in the mental lexicon

Morphological processing has been so extensively researched (Forster et al., 1987; Marslen-Wilson et al., 1994; Rastle et al., 2000; Gonnerman et al., 2007) that it seems no longer a question of whether morphological relatives prime each other, but rather, other than morphological priming, which factors influence the recognition of morphologically complex words? Investigating this will bring to light findings regarding how morphologically complex words are both organised and represented in the mental lexicon, prior to lexical access. This chapter gives an overview of popular models used to describe representation of complex words, research to support each. This will provide a background for the processing of complex words i.e. where the debate stems back to, and this will be useful when discussing the more up-to-date research later on in the paper.

Historically, there are two well-known, alternative hypotheses used to address the debate regarding how complex words are represented and organised in the mental lexicon. These are: The 'single unit' hypothesis and the 'decomposition' hypothesis. (Manelis &Tharp, 1977) Both hypotheses are supported by a large body of linguistic research and will be discussed below, in order to provide a background to the debate. Within the last 10 years however, the debate between the single unit hypothesis and the decomposition hypothesis has been concluded, with substantial agreement that decomposition is needed. The debate now turns to address what kind of information is relevant for the decomposition of complex morphology.

The single unit hypothesis claims that each affixed word is stored in the mental lexicon as an individual entry. This implies that the mental lexicon encompasses a relatively large amount of storage, as the stem word would be required to attach to every potential derivational and inflectional affix as a separate entry. The decomposition hypothesis claims that affixed words are represented internally as their individual morphemes and combined before lexical access. In this instance, monomorphemic words which are stems of affixed words would only need to be represented once in the mental lexicon.

An example of early research into the question of how complex words are represented is by Stanners & Neiser (1979), who attempt to address the debate through a series of four experiments. Their research was specifically concerned withhow a prefixed word is represented and accessed in memory i.e. as a whole word, or in terms of the individual component morphemes which the word is made up of. The first type of word contained the bound morpheme as the stem of the word, for example the word 'pro-gress', whilst the other type of word used a free morpheme as its stem, as in the word 'un-true'. The results revealed mixed findings, in that they implied at least one of the two types of words containing bound morphemes is represented in memory as a whole. On the other hand, it was implied that the stem and prefix can be mentally separated during the course of reading the word, which they labelled 'partitioning'. For words such as 'progress', both the unitary memory representation was accessed as well as the memory representations of words which share the same prefix, for example words such as 'ingress' and 'regress'. Therefore, this evidence supports both sides of the debate, claiming prefixed words are represented as a whole and also in terms of their individual morphemes. Although these results are still inconclusive with regards to how prefixed words are represented in memory, they lean more toward a unitary representation, supporting the side of the 'single unit hypothesis'.

Alternative research indicates that morphologically complex words are consistently broken down into their component morphemes, prior to lexical access. (Taft & Forster, 1975). This research attempted to identify how prefixed words are represented in memory, and also identifies the internal procedures at the point of lexical access, in other words, the point at which one is able to select a specific word from memory. Three lexical decision tasks were utilised, the results of which consistently indicated that just prior to lexical access a morphological analysis of words is carried out, whereby the word is broken down into its separate morphemes. This view supports the 'Decomposition Hypothesis', however, it is still inconclusive how prefixed words might be organised in memory prior to lexical access, i.e. as a whole or as individual morphemes, as the results suggest that they are decomposed immediately before lexical access occurs.

To make this position clearer and reinforce their view on decomposition, Taft & Forster (1975) also proposed a model of lexical recognition, which demonstrated how morphological decomposition is always necessary, both in the storage and in the retrieval of complex lexical items. This model demonstrated how prefixed words are always analysed in terms of their constituent morphemes before the process of lexical access, strongly siding with the 'decomposition hypothesis', although this research was strongly critiqued, which will be mentioned later on. It was additionally noted that, 'non-words' or 'pseudowords' which are stems of prefixed words, for example 'juvenate', take longer to classify than non-words which are not stems. This implies that the stems are directly represented somewhere within the lexicon. However, there is confusion over whether pseudo- stems such as 'admit' and 'permit' are accessed via the same lexical entry, (this being 'mit), or via separate lexical entries. Nonetheless, these findings differ from those by Stanners & Neiser (1979), implying that there is no unitary representation of prefixed words.

Early results from Manelis & Tharp (1977) challenge the decomposition approach, providing research in favour of the single unit hypothesis. The aim of their research was to investigate the recognition of affixed words through the use of two lexical decision tasks. The first experiment was mainly testing word latency for affixed words and non-affixed words. Prior to the experiment, it was hypothesised that the affixed words would be decomposed to stem and affix. A test would follow, aimed at determining whether the base and affix provide a valid combination. If so, the stem and affix would join, allowing the participant to recognise the affixed word. Participants were presented with pairs of words on each trial, and they were asked to select a positive response only if both items were words. This procedure was designed to elicit a slower response time when one item in the word pair was non affixed, as the response would be longer due to the need to process two words. It was hypothesised that subjects would change their processing for the second word in a word pair to speed up the processing. For example, if word one is DARKER, participants would be more likely to decompose SOMBER, as 'somb' and 'er'. (Manelis & Tharp, 1977) Although the second experiment was designed specifically to maximise the chance of decomposition, the results actually demonstrated no significant effect of interaction between the type of response and the type of test item. This indicates that the participants could not decompose the test items and process the bases individually, regardless of the bases having the potential to assist in determining a correct response, faster. Therefore, the results from this research supported the notion that complex words are processed via the Single Unit Hypothesis and not broken down.

The second of the two experiments was specifically designed to maximise the opportunity for decomposition. Participants completed a matching task, whereby they were presented with a set of target words which could also be a base form in affixed words, then asked to match the target words to the base form in affixed test words by pressing a button. There were two conditions, the test condition, and the non-word condition. If the items were processed as individual morphemes, response times would be faster in the test condition to the non-word condition. The findings showed no significant responses or interaction with regards to the type of test item which was shown to the participants. Therefore, it was apparent that the participants processed the test items as single units, regardless of the nature of the task encouraging decomposition of test words. Like the first experiment conducted by Manelis & Tharp (1977), the findings from the second experiment also supported the Single Unit Hypothesis.

One criticism of Taft & Forster (1975) was that they only look at prefixed words, and generalise the findings on decomposition to all affixed words (Manelis & Tharp 1977). Later research put forth by Taft et al (1986) indicates that morphological decomposition is more apparent in prefixed words than suffixed words, simply due to words being processed from left to right. This follows the assumption that as the prefix is the very first morpheme to be seen or heard when reading or speaking, the prefix is more likely to be decomposed than a suffixed word whereby the affix is seen or heard last. This is due to the brain acting upon the first morpheme which it comes across, and decomposing it before the full word has been seen or heard.

As this research aims to determine how affixed words are stored in memory and accessed, it is necessary to consider whether individual morphemes occur as separate entities to root words conveying their own individual linguistic information, or whether they are reliant on other variables such as meaning or frequency, to exist. This was investigated by Devlin & Gonnerman (2004) whose work was concerned with neural representations of morphological structure. The research specifically investigated whether morphology conveys a separate form of linguistic information, providing its own contribution to word recognition which is separate to form and meaning alone. The findings indicated otherwise, being consistent with the notion that morphology arises from the convergence of form and meaning. This research demonstrates that the separate components in morphologically complex words rely on semantics in word recognition. In addition, the separate components do not convey any additional form of linguistic information which are not apparent through form and semantics.

Rastle et al (2000) also provided an alternative viewpoint on the variables which influence morphological priming, through research which addressed whether language processing is organised on a purely morphological level, i.e. morphemes are treated differently (in both storage and processing) to whole words. Derivational morphology only was examined in this experiment. Two sets of priming experiments were used to investigate the role that morphological structure and semantic and orthographic relatedness play in early visual word recognition, respectively. There were three SOA points which were varied and examined via a masked priming paradigm in a visual word recognition task. The results indicated consistent priming effects for semantic relatedness across all of the SOA conditions. The key finding elicited from the data was that morphological structure was the variable which elicited the largest priming effect in early visual recognition, and this was independent of both the semantic and orthographic relationship between prime and target (Rastle et al, 2000).

The conclusion gained from these findings was that morphemically structured representations play a major role in visual word recognition as they are indicated as being distinct from semantic and orthographic factors. This furthers the knowledge of which variables are crucial for word recognition, and additionally which variables play a role how affixes are internally represented in memory. The results from this experiment would suggest that affixes are units independent of meaning and form, which are present further on in the recognition process.

Evidence for priming of words only by a shared affix could also help further the debate regarding how complex words are stored. This phenomenon has been researched and significant affix priming effects have already been demonstrated (VanWagenen, 2014).

Chateau et al. (2002) conducted an experiment to investigate priming of prefixes in English, against an orthographically matched, monomorphemic condition, for example dislike-DISPROVE vs. violin-VIOLATE. In this research, there were no significant priming effects observed, and therefore this opposes the notion that priming via the affix in an affixed word is valid. This was contradicted by research by Dominguez et al. (2010) who conducted a similar experiment investigating priming of prefixes and found significant affix priming when paired against an orthographic, monomorphemic condition. This research was strengthened by research conducted by Dunabeitia et al. (2008) who investigated priming of suffixes, and again, found significant priming effects. Taking this into account, it is also worth noting that the research conducted by Dunabeita (2008) and Dominguez (2010) was conducted in Spanish. There is no evidence to suggest that results regarding affix priming cannot be generalised from Spanish to English, although there are clear lexical differences between the two languages. For example, it has been stated that English is morphologically impoverished compared to Spanish (Amenta & Crepaldi (2012).

To summarise, research demonstrating affix priming (Dominguez, 2010; Dunabeita (2008) provides support for a distinct sub component in the mental lexicon dedicated to affixes. If this were the case, identifying what kinds of information are relevant to decomposition could uncover further information regarding sub components within the lexicon. Priming of affixes is a topic which is investigated within Experiment 1 of the present research. Taking into account the current research surrounding the debate, priming of affixes is an area which demands more attention in order to identify what variables are key in decomposition.

2.2 Semantic transparency and opaqueness

The semantic transparency or opaqueness of a word refers to whether the meaning is derivable based solely on its component parts. An example of semantic transparency is the word ‘agreement’, which denotes the state of being in accordance with something or someone. ‘Department’ is an example of a semantically opaque affixed word, due to its meaning not being conceivable based upon the component parts ‘depart’ and ‘ment’ alone. Opaque words require a preconceived meaning to allow them to be recognised. This paper occasionally uses the terms ‘consistent’ and ‘inconsistent’ as a way of describing whether or not, when attached to a word, the affix follows its consistent, more frequently used meaning, or strays from it. Due to the focus of the present research, these terms are favoured slightly over the terms opaque and transparent, as they imply this specific information about the units in question. The more common notions of ‘transparency’ and ‘opaqueness’ have been shown to influence how prefixed and suffixed words are morphologically decomposed or broken down, at the point of lexical entry. (Marslen-Wilson & Tyler, 1994) Research into lexical access has concluded that semantic priming is a factor which aids recognition in lexical decision tasks. This suggests a meaning based organisation of the lexicon, at least with regards to whole words. (Meyer & Schvaneveldt, 1971)

Research conducted by Marlsen-Wilson et al (1994) aimed to contribute to the opposing theories of word and morpheme-based representation in the mental lexicon by looking at words’ semantic qualities. They conducted a series of experiments, one of which was a cross-modal repetition priming task. It was noted in participants’ response times whether or not the prime had an inhibitory or facilitatory effect. They claimed that semantically opaque words were morphologically simple with no internal structure, and are therefore analysed as a whole. An opaque item such as ‘department’ will not be analysed in terms of the free stem plus affix at the level of lexical entry, as this would provide incorrect semantics. Semantically transparent words, on the other hand, are analysed in terms of their constituent morphemes.

Marslen-Wilson et al (1994) came to the conclusion that semantically transparent and semantically opaque words behave differently and are therefore analysed differently before lexical access. This led to the notion of a separate representation of semantically transparent words and semantically opaque words in the mental lexicon, and enforces the idea that semantic relationships govern morphological decomposition. However, it is worth questioning whether the body of research regarding the influence of meaning on morphological decomposition provides an accurate depiction of lexical representation in every day speech, or if this is only apparent under experimental conditions. Findings which demonstrate that meaning is a crucial factor which affects word recognition and encourages the decomposition of morphologically complex words has been replicated primarily in linguistic research using a highly controlled, experimental technique (Rastle, 2000; Marslen-Wilson et al, 1994).Therefore, one step towards concluding the debate regarding how crucial semantic relationships are to the recognition of morphologically complex words is word recognition elicited from participants in a natural environment. Although in recognising this need for more field data, as technology to investigate the language brain continues to advance and progress as in the case of neuroimaging techniques, testing participants in a natural environment becomes increasingly more of a paradox.

2.3 Findings from neuroimaging techniques

Event related potentials or ERPs are electrical potentials which are generated by the brain in response to a specific motor or cognitive event. The ERP technique has become a popular tool in areas of psychological and linguistic research to test the brain's response to stimuli. ERP data has been used to investigate the effect that semantically transparent, semantically opaque and orthographically related masked primes have on target words. (Morris & Frank, 2007) The data elicited showed both N250 and N400 effects in response to the primes. A reduced N400 component indicated greater facilitation, and this was present at the occurrence of semantically transparent primes. It was suggested that the semantically transparent representations were common representations which were regularly activated, and this regular overlapping of 'morpho-semantic' representations i.e. frequent morphemes elicited the reduced N400 component. Contrarily, semantically opaque primes activated different lexical representations, resulting in less facilitation and eliciting a larger N400.

Linguistic processing can be investigated through using an MEG neuroimaging technique. Two advantages of this technique are that it offers high temporal precision, in addition to being non-invasive. Evidence to support morphological decomposition was proposed by Solomyak & Marantz (2010), who used MEG to investigate processing of morphologically complex words. Three types of affixed words were investigated within a lexical decision task, these being: free stems, bound roots and unique root words. The analysis was taken 100-200ms post stimulus onset, and sensitivity was observed at the point of M130 and M170. Solomyak and Marantz firstly observed an M130 response in the left hemisphere which could indicate sensitivity to affix frequency or equally orthographic frequency, although is it unclear which. It was also possible to observe at the later stage of M170, the neurological response was particularly activated for free stems and bound roots. It was concluded that the M170 response indicated a genuine effect of morphological decomposition for morphologically complex words containing bound roots and free word stems.

MEG neuroimaging was firstly used to investigate the neural effects of morphological complexity in a series of two experiments (Zweig & Pylkannen, 2009). The types of words under investigation in this research were suffixed words (used in the first experiment) and prefixed words (used in the second experiment), with the independent variable being whether the word is simple or complex. These were investigated within a single word lexical decision task during an MEG brain analysis. It was hypothesised that neural activity is likely to occur at a pre-lexical early stage of processing, presumably in visual areas of the brain. The results from this study demonstrated that the morphological complexity of a word modulates the M170, which is neural activity around the 140-200ms time window, and typically the point which activates during facial recognition. However, the M170 in this research also indicated that decomposition is performed when the visual system detects an affix. For example, the neural activity detects that the word PRINTER is made up of two components whereas the word WINTER is only one. This research supports the findings of Solomyak & Marantz (2010) who found that the M170 response indicated a genuine effect of morphological decomposition. This research additionally provides evidence to accept the notion that the language processing system will perform obligatory decomposition at a pre-lexical level, a claim previously made by Taft & Forster (1975).

The FMRI technique was utilised in an experiment conducted by Gold & Rastle (2007) to investigate morphological priming for morphologically complex words, without any assistance from the meaning of their component parts. Taking into consideration results from recent linguistic research which used a masked priming technique to investigate morphological analysis; it was presupposed in this paper that morphological analysis could occur in semantically opaque words as a result of the brain recognising orthography. The results from FMRI indicated that morphological priming occurred simply as a result of the appearance of morphological structure, in semantically opaque pseudo- suffixed words such as in the word pair 'corner-CORN'. These effects could be separated from words which indicated semantic priming effects as well as orthographic priming effects. The findings from this experiment indicate that the structure alone of morphologically complex words has a bearing on morphological decomposition. With regards to the present study, these findings could offer an explanation for potential morphological priming and or decomposition in the case of semantically opaque affixed words, whereby the suffix does not follow any consistent, recognised meaning.

2.4 Word Frequency

Frequency is a factor which has proven useful in supporting morphological decomposition of affixed words. Lexical activation is the process whereby the lexical item being put forth can be recognised integrated into one's thought processes. Lexical activation is built upon the notion of frequency, as the lexical entry needs to be repeated in order for activation to cross a threshold whereby the lexical entry is recognised as a word. Frequent lexical items have a higher resting level, which allows them to reach the threshold for recognition faster (Embick et al, 2001).

This subject has been discussed extensively in psycholinguistic papers, many of which have reported on the 'word frequency effect', which demonstrates how people process common or frequent words differently to how they process uncommon or less frequent words, (Taft 1979; Rosenberg, Coyle & Porter, 1966; Savin, 1963). Frequent words have been found to be perceived faster and more accurately than infrequent words when listening to someone speaking (Savin, 1963), and frequent words can also be named faster than infrequent words when speaking (Oldfield and Wingfield, 1965). Rosenberg et al used a free recall task to investigate how adverbs such as ‘brightly’ and ‘briskly’ are represented and processed. The words which were studied and memorised were matched on surface frequency, and differed on the frequency of the adjectival stem. For example, ‘bright’ was one of the high frequency stems and ‘brisk’ was a low frequency stem. The results from the free recall task indicated that people were more easily able to recall words with high frequency adjectival stems, as opposed to the words containing adjectival stems which are low frequency. Therefore, the ease of recall of adverbs is influenced by the frequency of their adjectival stems, which could imply that people’s ability to recall other affixed words is influenced by the frequency of their stems, or affixes. This is a topic which has also been of interest to linguistic researchers (Taft, 1979; Taft and Ardasinski, 2006) who used a lexical decision task to investigate this, modelling frequency as a two-level variable,(high vs. low). This is similar to the method used in Experiment 2 of the present research.

Taft (1979) investigated how the word frequency effect can determine how prefixed words containing the same stem are stored in the mental lexicon. The lexical decision task reported provided evidence to support words being decomposed into their component morphemes for recognition. These findings support prior similar findings by Taft (1975) that prefixed words are decomposed into component morphemes for analysis. The prior finding that non word stems are directly represented in the mental lexicon (Taft, 1975) is also supported through the observation that reaction times in a lexical decision task to non-words which are stems of prefixed words (‘vive’ from ‘revive’) are longer than those to non-words that are parts of, but not stems of, non-prefixed words (‘lish’ from ‘relish’). Thus it is supposed that ‘vive’ could be directly represented in the lexicon, which would account for the longer reaction times to nonwords.

Manelis & Tharp (1977), previously mentioned above (Section 2.1) whose findings lean more in favour of the Single unit hypothesis, note that prefixed words could be decomposed for recognition, only what is directly represented in the mental lexicon could be fragments of words and not necessarily individual morphemes. This statement may provide an alternative explanation for the findings by Taft above.

2.5 Base Frequency effect

As mentioned, Taft (1979) took a strong stance on obligatory decomposition at the early stages of processing, i.e. the notion that decomposition always occurs to allow ease of word recognition. It was later noted that a way of determining whether or not decomposition of affixed words always occurs at the early stages of processing is to investigate what role the frequency of the stem plays in allowing for ease of recognition. (Burani & Thornton, 2003) Taft made well known what was termed the 'Base Frequency effect', which is the notion that a morphologically complex word is decomposed into its component morphemes (stem+affix) and recognised via its stem. The Base Frequency is a predicted result of the obligatory decomposition hypothesis, whereby base frequency elicits a facilitatory effect, when surface frequency is controlled for. This prediction was tested via a number of experiment, however it was demonstrated that the facilitatory effect of base frequency was not always present. This was therefore a problem for the obligatory decomposition approach.

Therefore, a dual pathway account of processing has become a popular account of processing for morphologically complex words. This supposes that whole word access and decomposition are both possible in word recognition. On a basic level, this account assumes that some types of word use decomposition of stem and affix exclusively, in an obligatory sense, however other types of word exclusively use whole-word access exclusively and have no need to decompose to support the ease of recognition. (Taft, 2004). This all or nothing, version of the dual pathway approach was also interpreted to mean that specific affixed words play more of an interactive role in processing, in that they activate (or actively choose) which pathway is engaged. (Bertram et al, 2000) This account may provide an explanation for why the base frequency effect does not always provide an advantage and indicate the notion of decomposition.

Circumstances whereby the base frequency does not provide an advantage in a lexical decision task was also investigated by Taft (2004). From this research emerged what was termed the 'Reverse base frequency effect'. This effect demonstrates that although it is the case that words with higher frequency stems providefaster responses than low frequency stems in a lexical decision task, the later stage of recombining stem + affix is more difficult for high base frequency words. This counterbalances the advantage of there being easier access to affixed words with high frequency stems. The combination stage is the point where it is important to discriminate words from nonsense words, and if there is a hindrance at this point, there is a clear disadvantage. (Taft, 2004).

The dual pathway notion has difficulties explaining how the reverse base frequency effect occurs, however sides with the notion of obligatory decomposition.

In summary, there exists a mass of research suggesting different routes for the recognition of affixed words, a few of which have been discussed above. To recap, there is the Decomposition Hypothesis which more recent research is in favour of, which states that words are represented in terms of their component morphemes prior to lexical access. This is the side of the debate which the present research heavily sides with. There is the 'Single Unit Hypothesis' which also has a body of research to support (opaque) words being accessed as a whole and not decomposed prior to lexical access, which although initially had research to support these claims, the Single Unit Hypothesis is now outdated. There is the Dual Pathway Account which allows both whole word access and decomposition, depending on the type of affixed word in question. In addition to these accounts of word recognition there are also additional variables which have proven to have a strong influence over how words are accessed and represented in memory, such as frequency. This research aims to narrow down exactly how affixed words are represented in memory and accessed for recognition.

3. The Present Research

3.1 Research questions and predictions

The present research consists of two experiments. (See Section 4.1 and Section 5.1 for a detailed version of each). Experiment 1 uses a priming technique within a lexical decision task to investigate meanings associated with three affixes. It aims to address the implications that semantic connotations have on the representation and retrieval of three specific affixes from the mental lexicon, before and during the point of lexical access. Experiment 2 also uses a lexical decision task, which is used to highlight the differences in reaction times between high frequency stems in affixed words and low frequency stems in affixed words. Experiment 2 additionally aims to address the implications of its findings on frequency for the storage and retrieval of affixes.

Both Experiment 1 and Experiment 2 have the shared goal to offer a basis to test the hypothesis that words consisting of stem+ affix are decomposed prior to lexical access and represented in terms of their component morphemes in memory, in the mental lexicon. The results of each experiment additionally aim to indicate that derivational bound affixes are stored in a semantic network, connecting one another in a similar way to the Spreading Activation Model.

The following section will outline the expected outcomes for Experiment 1 and Experiment 2, and what these outcomes might imply with regards to the organisation of affixes.

Firstly, there is expected to be a larger priming effect for semantically transparent affixed word pairs and a lesser or no priming effect, for semantically opaque affixed word pairs. For example, it is assumed that participants will recognise words like 'hopeful', (words which have a bound morpheme associated with a consistent meaning), faster, than they would recognise words which contain a bound morpheme displaying an inconsistent meaning, as in the case of the word 'bashful'. This finding would have implications for the organisation of affixes in the mental lexicon. If it is found that participants are primed by semantically consistent affixed words and not by semantically inconsistent affixed words, this would indicate that affixes are stored in a hub or network in the mental lexicon which is organised via meaning.

This finding will also imply a separation of affixed words into stem and affix before lexical access. This is due to participants recognising that the component parts of consistent affixed words are different in meaning to the component parts of inconsistent words and therefore processing them differently, and at different speeds. This hypothesis is based upon prior research on semantic transparency which states that complex words are decomposed into component morphemes (Marslen& Wilson, 1994).

Experiment 2 follows on directly from Experiment 1, additionally addressing how affixed words are stored in memory, although approaching the subject through investigating the variable of frequency instead of semantic connotations. Experiment 2 looks at how the frequency of stems in semantically transparent affixed words affects the representation of morphologically complex words in the mental lexicon and the ease of retrieval during lexical access.

One predicted outcome of Experiment 2 is that affixed words containing stems which are labelled as 'high frequency', will elicit a faster response time than affixed words containing stems labelled 'low frequency'. This will support the notion of morphological decomposition before lexical access, as participants would need to identify the distinct frequencies of the component parts of the test word and therefore mentally separate the stem and affix in order to reach a lexical decision faster. This will additionally give weight to affixes and stems being stored separately in the mental lexicon.

This prediction is based upon prior research which states that decomposing morphologically complex words into their individual parts would likely make them easier to process, because the individual parts are often of higher frequency than the whole word itself. (Nagy & Anderson, 1989)

4. Experiment 1

4.1 Overview

Experiment 1 examines three derivational bound morphemes and the role that meaning plays in their recognition when they are attached to suffixed words. The three bound morphemes under investigation were: –ie –er and –ful. These were chosen based on how common they are in everyday speech, and equally how easily they could be applied to both conditions; consistent meaning and inconsistent meaning or in other words transparent or opaque.

The terms consistent and inconsistent arise from identifying the nature of the complex word when the affix is attached to the stem. Each suffix (–ie, -er and –ful) carries a semantic connotation, or significance. The semantic connotation affects the meaning of the word which the suffix attaches to. For example, '–ie' is usually attached to a word to signify a term of endearment or used in a diminutive sense, for example 'doggie' or 'sweetie'. '–er' carries the meaning 'someone or something that does something', and is also the comparative in English, for example 'kind-er'. The comparative meaning of '–er' will be discussed in Section 6.3 with regards to potential issues with the test items in the present research. Lastly, '–Ful' is used to denote 'full of something', as in the case of 'hopeful'. There are also instances where these affixes do not change the meaning of the word in a predictable or consistent sense, as in the case of semantically opaque affixed words like 'bashful'*. In this instance, the suffix 'ful' does not automatically change the word to mean that the stem is 'full of something', as the word does not signify being 'full of bash.'Therefore, the stem is termed'inconsistent', as a result of its inconsistent nature, being unchangeable when combined with a derivational suffix. The terms consistent and inconsistent will be used when referring to the nature of the test words used in Experiment 1.

This experiment aims to investigate how meaning plays a role in the representation of affixes in the mental lexicon, with the expected outcome to be for participants to decompose consistent affixed words into their component parts for recognition, implying a separation of stem and affix in memory. To test this, a priming technique is utilised within a single word lexical decision task.[1]

4.2 Materials and Methodology

Participants: 29 monolingual speakers aged between 18-30. 12 M, 17F

Materials and Design: The three derivational affixes under investigation were -ie, -er, -ful. 60 word pairs were tested. Half of the word pairs were semantically transparent affixed word pairs and the other half were semantically opaque affixed word pairs. There were five words belonging to each of the suffixes -er, -ie and –ful, which appeared on a computer screen four times each, in order to eliminate the possibility of participants being able to predict the pattern of the word pairs. The remainder of the words used in the experiment were fillers (see appendix). These consisted of: 30 affixed non words, 30 un-affixed non words and 30 monomorphemic filler words. The non words and monomorphemic filler words were generated via no specific criteria, only that they were all similar in length and adhered to their main characteristic i.e. 'monomorphemic'. They were used within the experiment to served as distracters to prevent the use of demand characteristics from participants.

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[1]*A concern was raise by an examiner that the stem 'bash' could be more common within the word 'bashful' than it is as a stand-alone word, and this could be the case for other test words. This has been addressed via the English Lexicon Project (Balota et al (2007) and it is confirmed that 'bash' is five times more likely as a stand- alone word than within the word 'bashful', additionally the remainder of the opaque test words were checked against this criteria and it has been determined that this was not an issue for the present research.

Both words and non-words used in this experiment had high phonotactic probability in English. This was calculated using the English Lexicon Project (Balota et al, 2007). In other words, there was no phonetic disadvantage to recognising the non-words, as they were created to follow the same phonology patterns as regular words.

The surface frequency for both semantically transparent and opaque affixed words was calculated using the English Lexicon Project Website. (Balota et al. 2007) The average mean log surface frequency determined by the English Lexicon Project website (Balota et al., 2007) for 30 semantically transparent affixed words was: 8.24. The average mean log surface frequency of the 30 semantically opaque affixed words was: 6.83

All of the words used in the experiment including fillers were randomised so that each word appeared twice at the beginning of the PRIME-TARGET word pair and twice at the end of the word pair. E-prime was downloaded and run on a laptop with a 15" screen. A complete list of the words used in the present study can be found in the Appendix in Section 7.1.

Participants were recruited via volunteer sampling method. The participants were asked to sit at a table in front of a laptop screen and respond as quickly as possible to the words which would appear on the screen. They were instructed touse the keys 'a' and 's', depending on whether or not they recognised the word appearing on the screen as a word in English, or a nonsense word. E-prime was the software used to set up and run this experiment.

Table (1)

Affix	**Consistent meaning**	**Inconsistent meaning**
-ful	Careful-skilful	bashful-eyeful
-ie	Cutie-doggie	bookie-hippie
-er	Dancer-writer	sweater-poster

Table 1 (above) shows an example of the word pairs used in the Experiment 1, containing the three affixes under investigation and illustrating both conditions.

There were two main measurements which were used to analyse the data provided from the lexical decision task. These measurements were analysed and formulated into results. The first of the two measurements to be identified and analysed was Response latency. This refers to how long it takes the participant to decide if the word is a real word or a nonsense word.

The second measurement was response accuracy, which refers to whether or not the participant is correct in his or her judgement of real and nonsense words. The clean-up of the data set included az-score based elimination. Response times which were more than two standard deviations away from the mean were excluded, which meant that a total of 10% of response times were lost to this outlier threshold.

4.3 Results

This section will begin by describing the key data obtained from Experiment 1. It will then report what was found from the quantitative data analysis. The results will be explained in greater detail with reference to prior research and what these results mean with regards for the bigger picture of morphological decomposition and representation as a whole in Section 5.4.

Response Accuracy

Table 2

Experiment 1	**CW1 (PRIME)**	**CW2 (TARGET)**	**IW1 (PRIME)**	**IW2 (TARGET)**
Average accuracy %	96.32	98.81	93.42	96.78

Table (2) to show the average accuracy percentage for all four conditions.

The average accuracy rating for each participant across all four conditions: *consistent word 1, consistent word 2, inconsistent word 1, and inconsistent word 2* are displayed in the table above. It can be observed that the Consistent Word 2 condition provided a 98.8% accuracy rating. On average, participants responding to the Consistent words were 97.6% accurate, and 95.1% accurate when responding to the Inconsistent words. The Consistent Word condition therefore elicited the highest amount of accuracy from participants. This means that participants gave the most correct judgements for words which displayed a stem word which was consistent with its recognised meaning when attached to one of the three affixes.

Additionally, the Word 2 condition in both the consistent and inconsistent phase always elicited a higher accuracy rate when compared to the Word 1 condition in both consistent and inconsistent phase. Therefore it is likely the case that participants gave more correct responses after they had just seen a word with the same affix attached, and this was not dependent on whether the attached affix was used in a consistent or inconsistent sense. (Table showing complete set ofpercentages for accuracy for every participant 1-29 is available in Section 7.3).

Response Latency

Table 3

Condition	**Average of word1 RT (-ie,-er,-ful)**	**Average of word2 RT (-ie, -er, -ful)**	**Average of RT difference word1 & word2**
1.Consistent	569.44ms	520.90ms	48.5ms
2.Inconsistent	603.11ms	579.98ms	23.1ms

Table 3 shows average correct response times for word 1 and word 2 in both consistent and inconsistent conditions.

Key findings

It can be observed from Table 3 above that there is a visible difference in reaction times of the two groups (consistent and inconsistent). Word 2 consistently elicits a faster response time when it is preceded by the consistent prime. The average difference in response times between word 1 and 2 in the consistent condition is 48.5ms, whilst the average difference in response time for inconsistent words is 23.1ms. There is a faster response time for word 2 in both consistent and inconsistent conditions, although participants were 24ms faster responding to word 2 with the consistent words than the inconsistent words.

This means that participants were faster to respond to a suffixed word including a semantically consistent affix after they were previously presented with a word with the same affix attached, also being used in a consistent sense. Conversely, they were slower to respond to words pairs which contained the same affix, however used in an inconsistent sense, denoting no meaning.

Data analysis

Raw scores were input into SPSS for analysis.Data violated distribution normality using a Kolmogorov- Smirnov test in the consistent word condition for word 1 p=0.03. A Friedman test was therefore computed which showed that there was a significant main effect of condition X2(3)=50.67, p<.001. These results indicate that participants had faster response times in the consistent condition, with the fastest responses being in the consistent word 2 condition (M=520.90, SD= 94.9), compared with the consistent word 1 condition (M=569.44, SD= 78.74). This suggests that the participants were primed by word 1 in the consistent affix condition, which indicates that they benefitted from the consistent meaning of the affix attached to word 1.

4.4 Discussion of results

This section will review the results provided by Experiment 1, recapping on the key data obtained and highlighting the main significant findings. These results will then be explained with regards to what they mean for the bigger picture of decomposition, and which previous literature they are consistent with. This section additionally aims to provide an explanation for why these results have occurred and whether or not they differ from the predicted outcomes in Section 3.1.

Response Latency

Table 3 shows average response times for word 1 and word 2 in both consistent and inconsistent conditions as well as the average difference in response times between word 1 and word 2, in both conditions. From the data presented in Table 3, it is firstly noticeable that affixed words containing consistent morphemes are processed differently to affixed words containing inconsistent morphemes. This is evident from the participants' faster responses to words in the consistent condition. The average difference between Word 1 and Word 2 in the consistent condition was 48.5ms, as opposed to the inconsistent condition which exhibited a smaller average difference between Word 1 and Word 2, of 23.1ms. From this it can be said that the consistent condition implies a larger priming effect, in other words, this is the condition whereby participants are at an advantage in accessing lexical entries and distinguishing real English words from non-words.

One possible explanation for this advantage is as follows:

When the prime word is encountered, the participant decomposes the prime into stem+ affix. The semantics of the affix remain activated so that when the target word appears, the participant decomposes it into stem + affix faster. In the case of the semantically opaque words, the affix of the target word is not associated with the same meaning as the affix of the prime word therefore the amount of facilitation is reduced, eliciting a slower response time.

Equally, competition is an important factor in lexical access. If affixes compete for activation during the recognition of a complex word, it could be the case that in successfully accessing the affix for the prime word, the affix of the target might be suppressed, rendering it less active than usual. This would therefore involve an increased cost for activating it sufficiently for recognition.

The differences in response times between consistent and inconsistent suffixed words used in Experiment 1 could also indicate a separation between stem and affix in the mental lexicon, prior to lexical access. This means that both the stem and affix are represented independently in the mental lexicon. When performing a lexical decision task, it is crucial that the words displayed are recognised with speed and accuracy. It is at the point of lexical access when the stem and affix (which were previously independent), join together, creating the whole suffixed word. Findings proposed from research by Marslen & Wilson (1972) support the notion that stems and affixes are represented independently. Results from Experiment 1 might suggest that the semantic connotations associated with words in the consistent condition of the task play a role in speed of lexical access. Data obtained from Experiment 1 would be consistent with the notion of a mental separation between stem and affix before lexical access occurs. This theory supports the decomposition hypothesis and is coherent with the predictions for Experiment 1, stated in Section 3.1.

A separate theory of morphological representation by Marslen-Wilson & Tyler (1994) states a clear difference between semantically transparent and opaque words. The theory claims that semantically transparent words are always decomposed for word recognition, unlike semantically opaque complex words which are always accessed in their whole form. If semantically opaque words were addressed with regards to their individual component parts before lexical access, it is claimed that this would provide incorrect semantics, rendering the meaning of the word incorrect. Data provided by Experiment 1 demonstrates through response times that opaque and transparent affixed words are processed differently. This theory put forth by Marslen-Wilson & Tyler (1994) would account for the faster response times in the inconsistent condition of Experiment 1. The notion of decomposition of transparent affixes is in a sense consistent with the predictions put forth in Section 2.1, however this theory also states that semantically opaque words have no internal structure, which cannot be justified for sure solely based upon the data obtained from the present research. The present research does however, support the predictions put forth that derivational bound morphemes are stored in a semantic capacity in the mental lexicon. However, in stating this, it might also be true that there are other variables responsible for the storage and internal representation of bound morphemes or suffixes such as frequency (addressed in Experiment 2 and discussed in Section 4.4 and 5.1 respectively. Therefore, there is no strong conclusion regarding exactly how and where affixes are represented in the mental lexicon, only that semantic relationships could be a factor which influence this.

Response Accuracy

Table 2 provides an overview of average accuracy rates across all four conditions. It can be observed that on average participants are more accurate when responding to the target word in a word pair, than the prime word. In the consistent condition, participants are on average 2.5% more accurate to respond to the target than the prime, and in the inconsistent condition they are 3.4% more accurate to respond to the target word than the prime. In addition, participants are on average 2.465% more accurate to respond to words when in the consistent condition compared to words which are in the inconsistent condition.

These results demonstrate an advantage for accuracy for participants responding to the consistent word condition. The data obtained firstly appears to be in line with the conception that semantically transparent or in this instance consistent affixed words are more easily accessible than inconsistent affixed words.

One explanation for participants' responses being more accurate when responding to a target word than a prime, is that the data could simply be indicative of participants answering more accurately after seeing an affixed word immediately before, containing exactly the same suffix. Research additionally suggests that morphological and orthographic priming are both factors which influence speed of word recognition (Rastle, 2000). If the results from Experiment 1 are influenced by morphological priming as well as influence from semantic opaqueness and transparency, this introduces the prospect of there being more than one crucial variable which influenced the results of Experiment 1.

One study using ERP data conducted by Morris & Frank (2007) noted that semantically transparent representations were more regularly activated than semantically opaque representations and orthographically related primes. This implies that semantic transparency is correlated with lexical frequency, meaning transparent words generally have a higher frequency than opaque words. This is a claim which appears to be supported from the data elicited from Experiment 1 of the present research. The mean log frequency calculated using The English Lexicon Project (Balota et al. 2007) for semantically transparent words was 8.24, while the average mean log surface frequency for semantically opaque affixed words was 6.83. Taking into account findings from prior research (Taft (1979), differences in frequency are likely to be an influencing factor for the faster response times obtained from Experiment 1, with semantically transparent words having an advantage over semantically opaque words.

An explanation for how this advantage is known to occur is as follows: Each time a semantically transparent word is accessed; this alters its resting level of activation. This is a function of how frequently the word is accessed. Therefore, if a semantically transparent affixed word is regularly accessed, it has a high resting level of activation, which allows it to reach a threshold for recognition faster. The Spreading Activation Model claims that in addition to the affixed word alone gaining activation, the nodes which surround the word linking to similar words are also activated. (Roelofs, 1992) These similar words can be semantically similar, phonetically similar, and in the case of the present research, they would be semantically and morphologically similar. This leads to the similar words also being more easily accessible which allows for them to be faster to retrieve and in a lexical decision task, there is a higher chance of them being correct. This theory provides a sound explanation for the results elicited from Experiment 1, i.e. why participants were more accurate when responding to consistent words than inconsistent words, taking into account their average mean log surface frequency levels (shown in detail in Section 3.2).

The results obtained from examining response accuracy may also provide further evidence for claims stating that semantically opaque words are processed in their whole forms and not decomposed for recognition. If opaque affixed words have lower levels of surface frequency and therefore a lower level of resting activation, the results showing that participants take longer to respond to opaque words would be in support of the Single Unit Hypothesis (Manelis & Tharp, 1977) On the other hand, if the individual morphemes present in affixed words contain their own independent levels of frequency, for example if opaque words contain high frequency stems or root words, this could alter the judgement times within a lexical decision task, whilst also supporting the Decomposition Hypothesis (affixed words are represented internally as their individual morphemes and combined immediately before lexical access).

In almost all experimental methods it is likely that not all factors can be controlled for and therefore there will be extraneous variables. However, in the present research, controlling for frequency has the potential to bring to light more information regarding decomposition and representation of affixed words, and therefore further investigation into frequency is required in the present research.

To summarise the findings from Experiment 1, it was demonstrated that participants are faster to respond to affixed words containing a consistent meaning than an inconsistent meaning. This strongly implies sensitivity to meaning within the hub or network in which affixes are represented and organised. Additionally, participants are on average more accurate when responding to affixed words (in a lexical decision task) when they are preceded by an affixed word containing exactly the same affix. This implies a presemantic level of representation in the mental lexicon whereby morphologically complex words are decomposed based on their orthography. Lastly, faster response times in the consistent condition may also imply that frequency is a variable which is crucial to affixed word recognition and influences the organisation of affixes in memory. This will be examined in Experiment 2 and discussed.

5. Experiment 2- Frequency of stems

5.1 Overview

Given that the results elicited from Experiment 1 may have been influenced by extraneous variables such as surface frequency, Experiment 2 controls for surface frequency by ensuring that all of the test words are of the same mean log surface frequency, with the independent variable being frequency of the stem. This therefore rules out the possibility of participants being influenced by the surface frequency of the test words. This experiment also ensures that results are not influenced by semantic relationships between words or morphemes by only using semantically transparent test words. Due to these variables being controlled for, Experiment 2 encourages the notion of decomposition as participants would need to recognise the base frequency of the test word in order to process the whole word faster, which requires separation of the stem and affix.

Experiment 2 investigated 16 derivationally suffixed words, all semantically transparent. The aim of this experiment was to investigate how frequency plays a role in the recognition of affixed words. This will provide further insight into how affixed words are represented in memory, whilst additionally providing support for frequency being a fundamental factor which influences participants' responses in a lexical decision task. These results have the potential to be transferred to how people choose words in conversation, writing, and single word tasks. If frequency is shown to be an influencing factor over speed of recognition of affixed words, this expands what the hypothetical sub component dedicated to morphemes (mentioned in section 1.1) might consist of. In addition to accepting that there exists a semantic hub or network whereby single units or morphemes exist, frequency will be an additional factor to be considered in drawing up a hypothetical picture of how affixes are represented in memory.

This experiment is interested in examining the difference in response times of recognition between high base frequency stems in affixed words and low base frequency stems in affixed words. Section 1.5 discussed a process called 'The Reverse Base Frequency Effect' (Taft, 2004), whereby participants are at a disadvantage when the base or root word is of a higher frequency. Taking into account this research and its critiques, the present research predicts to find a significant difference between high base frequency affixed words and low base frequency affixed words. At this stage and taking into account critiques of this theory, it is uncertain whether or not high frequency of the stem words will have a negative effect on processing.

Surface frequency in this experiment is controlled for by ensuring all of the words used in the lexical decision task were around the same surface frequency. (Detailed in Section 5.2) The independent variable in this experiment, was the log frequency of the root or stem word, for example, 'fear' was a high frequency stem in the affixed word 'fearful'. If the results demonstrate a difference in reaction times between high and low frequency stems in affixed words, this strengthens one of the main conclusions of Experiment 1, supporting decomposition of affixed words prior to lexical access.

Experiment 2 additionally aims to clarify results gained from Experiment 1. Experiment 1 gave reason to believe that other than semantic transparency and opaqueness, there were other influencing factors which might have determined the participants responding faster to semantically transparent affixed words. This research will determine whether or not frequency is a variable which will have likely played a role in response accuracy and response latency, and as mentioned previously, this will change the hypothetical picture of on what basis affixes are organised and stored in the mental lexicon.

5.2 Materials and Methodology

There were a total of 16 test items used in the experiment, all of which were semantically transparent, suffixed words. Half of the test words contained stem words which were deemed to be 'high frequency', whilst the other half contained 'low frequency' stem words. Each test word ended in either –er, or –ful. Four '-er' suffixes and four '-ful' suffixes were attached to the high frequency stems, and four '–er' suffixes and four '-ful' suffixes were attached to the low frequency stems.

Surface frequency was controlled for by inputting all of the test words, in their whole forms, into 'The English Lexicon Project' (Balota et al. 2007). All of the test words had a mean log surface frequency of 7.5, which also calculated using the same website. Individual stem frequencies were calculated for each test word by inputting only the stem words into the query box. This generated the mean log frequency for each stem. The mean log frequency refers to the average of the amount of times the word appears in the database. All stem words with a higher mean log frequency than 8.2 were deemed 'high frequency', and stem words which displayed a mean log frequency of below 8.2 were deemed 'low frequency'. All of the high frequency stem words had an average log frequency of 10.6, and the low frequency stem words had an average log frequency of 6.8. 8.2 was chosen as the cut off frequency as it was a fair middle number in between the high and low frequency words.

The remainder of the words used in the experiment were fillers. These were: 16 monomorphemic words, 16 monomorphemic non-words and 16 affixed non words containing the suffixes -er and -ful. The fillers were used to distract the participants so that they would not grasp which lexical items were being tested in the task.

The method was similar to the method used in Experiment 1, participants were required to perform a lexical decision task whereby they had to judge as quickly as possible whether or not they recognised the word which appeared on the computer screen. Each word appeared for 2000 milliseconds unless responded to, before moving on to the next word, with a fixation lasting 500 milliseconds between each word. The participants were asked to sit in front of a laptop screen and press the 'a' key on the keyboard to signify the word being a real word in English, and 's' to signify a non-word. Before the task began they were talked through the instructions and asked to sign a consent form.

5.3 Results

Raw data was input into SPSS. An independent t-test was conducted and results showed that the high frequency stem condition (M=610.8, SD=90.2) elicited significantly faster response times than the low frequency stem condition (M-658.4, SD=97.1)t(29)= 5.54, p<.001.

These results suggest that the high frequency stems attached to the semantically transparent affixed words were more easily accessible to the participants, eliciting a faster response time.

5.4 Discussion of results

This section will review the main significant findings from Experiment 1 and their implications with regards to the bigger picture of representation of affixes. Both the findings of Experiment 1 and Experiment 2 will be taken into consideration when discussing implications for the representation and storage of affixes in the mental lexicon. The results from the present experiment will also be judged whether they are in line or differ from the predicted outcomes which are outlined in Section 2.1, and why this might be the case.

The main significant finding from Experiment 2 was that participants displayed much faster reaction times for high frequency stem words than low frequency stem words. This indicates that they were likely benefitting from the high frequency of the stem. This shows that participants process high frequency stem affixed words differently to low frequency stem affixed words, which demonstrates a separation of stem and affix during lexical access. This conclusionis in agreement with one of the main findings from Experiment 1, which also demonstrated a separation of stem and affix prior to lexical access, through faster response times to semantically consistent affixed words. The findings from this experiment consolidate similar findings into prefixed words, claiming that morphological decomposition occurs at an early stage of processing, and words are decomposed into stem and affix whereby they are recognised via their stem, and later combined together. (Taft,1975)

With regards to the expected outcomes, the results gained from the task confirm what was predicted in Section 2.1, this being that affixed words containing stems which are labelled as 'high frequency', will elicit a faster response time than affixed words containing stems labelled 'low frequency'. This prediction was based on previous literature demonstrating how frequency is an influencing factor in word recognition (Burani& Thornton, 2003; Taft, 1979). Predictions for Experiment 2 also took into account research describing the phenomenon known as the Reverse Base Frequency Effect. (Taft, 2004) This was the recognition that the later stage of recombining stem + affix is more difficult for high base frequency words, which fundamentally counterbalances the advantage of there being easier access to affixed words with high frequency stems. As there is a hindrance at the combination stage, the stage whereby it is crucial to be able to discriminate words from non-words, this indicates a clear disadvantage. However, it was not predicted in this paper that this would be the case. Although the effect has been shown in the paper by Taft (2004), the body of linguistic research into frequency appears to side more with the notion that high frequency provides an advantage for word recognition (Taft, 1979; Rosenberg, Coyle & Porter, 1966; Savin, 1963).

As participants' response times are shown to be significantly faster when responding to a high frequency stem in an affixed word than a low frequency stem, the results gained from Experiment 2 do not support the idea that there exists a disadvantage for recognition at the point where the stem and affix combine. The results in fact indicate the opposite, supporting the more widely referenced Base Frequency Effect.

The advantage of frequency is due to high frequency stems in affixed words having a higher level of resting activation. It is noted that words with a high level of resting activation are able to reach the threshold for recognition faster than low frequency words. Therefore, in the task presented for Experiment 2, it appears evident that participants were using the high level of resting activation to reach lexical access faster than they were with the low level activation words, and then combining the affix after. This is a highly probable explanation as as stated, all of the test words used in Experiment 2 had the same mean log surface frequency. As the lexical decision task requires a fast response, all of the test words are competing with each other for which can be responded to the fastest. As in the case of the test affixed words, the surface frequency is not a variable which can assist speedier recognition of one word over another, therefore as the component parts vary to each other, this prompts the notion of decomposition.

With regards to what the results from Experiment 2 mean for the bigger picture of affixed words, one conclusion which can be drawn from these findings is that there is a strong possibility that stems are organised on the basis of their level of resting activation in the mental lexicon. Additionally, it can be said that decomposition into component morphemes occurs during the processing of high base frequency affixed words. This points toward a layout of the mental lexicon which contains single morphemes only and prioritises frequency.

In summary, Experiment 2 was created to investigate whether frequency is a key variable which influenced the results gained from Experiment 1.This would suggest that the priming effect elicited from Experiment 1 was also due to frequency and not entirely the semantic relationship between consistent affixed words. It was apparent that stem frequency is a factor which affects response times when surface frequency is held constant. Further research is required in order to determine whether affixes are organised in the mental lexicon through a network which relies on the notion of frequency.

6. General Discussion

6.1 General discussion

In this section the key findings from both experiments will be recapped and the conclusions drawn from them will be discussed. It will also be debated whether or not these findings are consistent with the body of literature around morphological decomposition, and why these outcomes are likely to have occurred. Following this, it will be considered how conclusions drawn from the present research shed light on the bigger picture of decomposition, and what can be said about the representation of affixes in the mental lexicon. Limitations of the present research will also be mentioned, in other words, factors which should be taken into consideration when assessing this research. Lastly, future directions for research dedicated to the topic of morphological decomposition will be illuminated.

It is also worth clarifying at this point in the paper that although Experiment 1 and Experiment 2 use suffixes in suffixed words to investigate morphological decomposition and recognition, the premise of the present research is also to contribute to the understanding of the organisation of affixes in general. Therefore, the conclusions drawn from Experiment 1 and Experiment 2 are generalised to affixes, instead of referring the findings solely to suffixes and suffixed words. Although it has been claimed that prefixes and suffixes behave differently during recognition in English due to words being read from left to right (Taft et al, 1986), this research takes the stance that the internal representation of prefixes and suffixes in the mental lexicon fundamentally remains the same.

The first aim of Experiment 1 was to investigate semantic connotations associated with three affixes, through a priming experiment.The second aim of Experiment 1 was to investigate the representation of affixes in the mental lexicon, in other words to find out: where are affixes stored in memory? Taking into account the literature currently existing on the topic, it was predicted that participants would be primed by an affixed word containing an affix with a similar consistent semantic meaning.

With respect to the first aim, it was demonstrated that participants responded significantly faster to words when preceded by a consistent affixed word as opposed to when the word was preceded by an inconsistent affixed word. This strongly suggests that there was a priming effect present. It is likely that the priming effect arose as a result of participants retaining and accessing the consistent affixed prime in a semantic space in the mental lexicon, and associating this with target word which displayed the same semantic qualities. Therefore, one conclusion drawn from the results gained from Experiment 1 was that affixes exist in a semantic space in memory, with meaning being a factor which influences the internal organisation and storage of affixes, which has an effect over the accessibility of the affix, effecting recognition. Thus, these results are consistent with accounts which state that semantic associations play a role in visual word recognition of morphologically complex words.

One reason that the present research predicted that this would be the case is that prior research predicted a similar outcome. Additionally, semantic priming has already been demonstrated as a technique commonly used in lexical decision tasks to obtain information regarding how the mental lexicon is organised. (Meyer &Schvaneveldt, 1971). Results from such research concerned with lexical representation strongly suggest a meaning based organisation of the lexicon with regards to compound words.Therefore, later research predicted that semantics would also govern storage and recognition if complex words, which was found to be the case in this study.

Experiment 1 gives weight to the idea that affixes reside in a semantic capacity in the mental lexicon, however, there is as of yet no evidence to suggest that affixes attached to semantically inconsistent words follow the same representation. Research suggests that opaque affixed words for example, 'bashful', exist as a whole entry, or are simply not broken down. This is supposedly as they would provide incorrect semantics if decomposed into root and affix and then later joined together. (Marlsen-Wilson et al, 1994),

Although the inconsistent affixed words were significantly less primed than the consistent words used in Experiment 1, the data elicited from the word latency data analysis demonstrates that it is still possible to observe a slight priming effect for inconsistent affixed words. It could be the case that participants (consciously or unconsciously) recognised that the test word in the prime position i.e. the first word in a word pair, contained the same affix as the second word in the word pair, regardless that the words are not influenced by a semantic connotation, as in the case of the consistent words. It was concluded that the slight priming effect for inconsistent affixes arises simply from form, or orthography. This is a theory which has been demonstrated in prior research into morphological decomposition (Rastle, 2000; Longtin et al, 2003).

Experiment 2 was necessary to investigate the frequency variable in isolation. This is due to surface frequency being demonstrated to be an important factor in lexical decision research in addition to a potential factor which had a crucial influence over the results elicited from Experiment 1. Therefore, one of the aims of Experiment 2 was to investigate whether surface frequency played a significant role in participants' response times in Experiment 1 through a lexical decision task controlling for surface frequency and semantic transparency. The second aim was to contribute findings toward how affixed words are represented in the mental lexicon, with an inclination toward decomposition.

With respect to the first aim, response latency results from Experiment 2 indicated that frequency is factor which plays a role in word recognition. Results provided a clear significant difference between the response times to high frequency stems and low frequency stems. As mentioned earlier (in Section 5.4) the results do not support the notion put forth by Taft (2004) that there is a disadvantage from high base frequency at the combination stage, alternately, the results show no such disadvantage, only an advantage from the high frequency stems. These results therefore do not support the Reverse Base Frequency Effect. One reason for this could be that the affixed words used were easier to combine stem+ affix at the combination stage than previous words investigated in lexical decision tasks.

Experiment 1 together with Experiment 2 provide evidence to suggest that affixes reside in a network in the mental lexicon which is sensitive to frequency and semantic transparency. This paints a clearer picture of on what basis affixes are organised internally, as it is now known which variables they are affected by when it comes to being chosen for word recognition. However, one question which is unknown is: which variables take priority in lexical decision, i.e. which variable will prove the most crucial in determining people's lexical choices, and how is this reflected in affixes' storage in memory?

If frequency was the most influential factor over the recognition of affixed words, it would be the case that the data elicited from the present research would act accordingly. This would look like semantically consistent affixed words in the first condition being responded to faster than affixed words in the semantically inconsistent condition, regardless of whether they are in the PRIME or TARGET position. However, this is not the case. Results elicited from the first experiment show that the second word in a word pair i.e. the target is on average always faster to be responded to than the first word in a word pair, i.e. the prime. This is true for both consistent and inconsistent conditions. Therefore, although it is the case that frequency is a key variable which has an effect over subjects' recognition of affixed words, it does not override the effect which meaning has on the recognition of affixed words. Both of these variables do however exist in harmony to promote the idea of decomposition prior to lexical access.

In accepting that decomposition of affixed words is a likely theory, it is also necessary to consider that word recognition may also be influenced by lexical circumstance. Prior research describes this as, 'how the chosen affix interacts with the root'. (Burani & Thornton, 2003). The present research supports this hypothesis through demonstrating that consistent words are processed differently to semantically inconsistent words (data analysis from Experiment 1).

This research additionally challenges the idea that semantically opaque or inconsistent affixed words are represented as a whole in the mental lexicon and not decomposed for lexical access. This is a stance which is popular in much research as well as the Dual Pathway Account of processing (Bertram et al, 2000), although the present research finds no evidence to support this idea. Instead, the present research strongly implies that affixes are influenced by a range of variables and this sensitivity to multiple factors such as meaning, form and frequency shape the way which affixes are organised within the mental lexicon.

To conclude this section, both Experiment 1 and Experiment 2 had the shared aim to investigate how affixes are stored and managed before lexical access. Both sets of findings from Experiment 1 and Experiment 2 support the notion that morphemes are stored individually before lexical access, and are therefore in line with the Decomposition Hypothesis. This hypothesis claims that monomorphemic words which are stems of affixed words as well as compound words would only require to be represented once in the mental lexicon, which paints a minimalist picture of how words are represented in the mental lexicon, i.e. only once, then joined together for lexical access like a jigsaw puzzle. Although it is noted in prior research that in some cases (for semantically inconsistent words), the present research has demonstrated that it is not the case that semantically inconsistent words are processed as a whole, they are also separated into stem and affix for word recognition. Taking this into account, it appears likely that the network which affixes reside in the mental lexicon is not solely dependent on semantic connotations, but that there are multiple variables which measure how accessible a particular affix is, in a particular context. In stating this, it is the case that the conclusions regarding how affixes are represented in the mental network drawn from the present research are purely speculative and still require further evidence.

6.2 Summary

To summarise, this research investigated how suffixed words are represented in the mental lexicon, with a strong inclination toward the Decomposition Hypothesis. Two experiments were used to investigate this, each focusing on a different variable known to influence word recognition. Experiment 1 examined the effects of semantic transparency and opaqueness (dubbed consistency and inconsistency) on suffixed words through the use of a priming technique in a lexical decision task. The data analysis from this experiment demonstrated a significant priming result for semantically transparent affixed words, suggesting that participants benefitted from the consistent meaning of the affix attached to the prime. The analysis of results also showed a non-significant slight priming effect for test words in the inconsistent condition, suggesting a presemantic processing stage, in other words participants were benefitting from the orthography alone of the individual components within the affixed test words. It was equally noted that the surface frequency of the test words was a variable which could have influenced the response times due to participants being faster to respond to consistent affixed words which had a high surface frequency when compared to the inconsistent affixed words which had a low surface frequency.

This led to Experiment 2 being conducted which controlled for surface frequency and semantic relationships by only looking at semantically transparent affixed words with a similar mean log surface frequency. The data collected from Experiment 2 demonstrated that participants are significantly faster to respond to affixed words containing a high frequency stem than a low frequency stem, suggesting firstly that frequency is a crucial variable in influencing the recognition of affixed words and secondly that affixed words are decomposed into their component morphemes prior to lexical access. It was overall concluded that semantic transparency, frequency and orthography are variables which have a strong influence on the representation of affixes in the mental lexicon and give weight to the notion of decomposition of morphologically complex words prior to lexical access. It is not possible at this point to state which of these three variables is most crucial for determining how affixes are represented in memory, only that they each play a valid role.

6.3 Limitations of the present research

Whilst conducting the present research there were issues which arose which were not possible to be fully addressed within time frame set for both experiments. These issues will be discussed in this chapter so that they can be taken into consideration, when reviewing this paper as a whole. Issues surrounding the methodology used in Experiment 1 will first be taken into consideration, in addition to how they were attempted to be resolved. Limitations of the methodology used in Experiment 2 will be discussed after, and lastly issues relating to the paper as a whole will be mentioned and discussed.

Experiment 1

Experiment 1 utilised a lexical decision task as a means of investigating semantic connotations associated with three affixes. One issue with using a lexical decision task to investigate priming effects is that it is vulnerable to participants using a predictive strategy. This can occur when the relationship between the prime and target pairs becomes obvious, and therefore easy to predict. One way of addressing this issue is to use a masked priming technique, whereby the prime word is 'masked' by a random string of letters or hash symbols which occurs before the prime, usually only appearing for approximately 50ms, ensuring the prime does not get consciously acknowledged. (Forster & Davis, 1987)

I attempted to address this issue by randomising the order of the PRIME-TARGET pairs so that the relationship between prime and target is less obvious to the subject. Each word in every PRIME-TARGET pair appeared 3 times as a prime (i.e. at the beginning of the word pair) and 3 times as a target. This reduces the chances participants being able to predict which word will follow the prime. However, it is also the case that the large amount of repetition of the same word over and over may have affected the significance of the results.

It also remains unclear whether or not the priming effects observed in Experiment 1 are the result of activation of lexical entry, or simply the result of an episodic memory of the prime influencing the decision to process the target. This could equally have been addressed by a masked priming paradigm, which was not employed in Experiment 1.

Another potential issue with using a lexical decision task to investigate semantic priming effects is that there is the possibility of the stem words attached to the affixed prime being closely semantically related to the stem attached to the affixed target word, and therefore eliciting a priming effect. One study which utilised a lexical decision task to investigate prefixed and suffixed words found that the affixed words being investigated were primed equally well by their stems, when the stem words were similar. Grainger, Cole & Sengui (1991)

Taking this into consideration, it is important not to disregard a relationship between stems in the target-prime pairs which could result in identity or semantic priming. I attempted to address this by ensuring there was no blatant relationship between the stems attached to the affixed words being investigated. However, ‘dog’ and ‘bird’ were both stems which were attached to the suffix ‘–ie’, which could be at risk of participants calling upon similar stem words existing in a semantic capacity.

Five of the words used in Experiment 1 were not standard dictionary terms. These were; foodie, doggie, birdie, kiddie and goalie. Although when analysing the results there were no differences which were significant in regards to response latency or response accuracy for ‘ie’ words, it could be the case that participants were more inclined to decompose these words for recognition, due to them not being a standard entry in the English dictionary and therefore less recognisable as a whole word. This did not impact the results, although it is something which should still be considered.

The amount of words used in both Experiment 1 and 2 were limited. For future research, it is important to have a larger sample of test words, in order to make more firm claims regarding how these items have an effect on morphological processing. Additionally, polysemy of words such as ‘bumper’ and ‘sweater’ (-er also being a comparative in English) may have been a confounding factor, influencing the results. It is impossible to know without controlling for this, whether the alternative meanings of the words came into play in participants’ lexical decisions, and therefore this should be controlled for in future research. Equally, there was no control for inanimassy with words such as ‘dancer’ and ‘sweater’, i.e. one being animate, and one, inanimate. Therefore in future research this is a factor which should be addressed.

Experiment 2

Experiment 2 calculated mean log frequency for stem words and surface frequency for affixed words using an Americanwebsite‘The English lexicon project.’ This website collects normative data for over 40,000 words across 1200 different subjects and stores them in a database (Balota et al, 2007). Whilst the website provides useful in allowing researchers to easily obtain word lists with specific lexical characteristics, the present research was conducted on participants from the UK. Although America and England have certain obvious differences in vocabulary, it is assumed in this experiment that the words used in the experiment have similar frequency levels in both American and British English. However, it could be the case that there is a discrepancy between the mean log frequency levels of whole affixed words or stem words in American and British English.

Although the mean log frequency was calculated for each stem word affixed word tested, it is also important to take into account individual differences which could have interfered with the lexical decision task. In the case of individual differences, outside variables such as the participant's profession may slightly influence his or her perception of words. For example, if one subject works as a baker, the stem word 'bake' would be likely to have a particularly high resting activation level due to it being a frequent word in the subjects' vocabulary, even though it is dubbed in this experiment as a 'low frequency' stem word. Taking this into account, it may be the case that participants are sensitive to familiar words eliciting a faster response time to them in a lexical decision task, however, it would most likely not be the case that this would affect the results, as an average is taken across all 30 participants, eliminating individual differences. Equally during the clean-up of the data, anomalies are either disregarded or examined. This may be an area which future research could look into, although frequency of usage has already been described in a model by Taft (2004), it did not include individual differences which could be an interesting area of investigation.

Inferential statistics were not performed on Experiment 2, additionally ideally mixed effect analyses coupled with model comparison would mean that potential significant data could be obtained from this experiment, which could have had more of a firm bearing on what the results indicate with regards to frequency and morphological decomposition.

Overall research

The findings implicated by the present research provide a good foundation to accept the notion of morphological decomposition occurring prior to lexical access for suffixed words. It is worth noting, however, that due to both Experiment 1 and Experiment 2 investigating semantic associations and frequency of English words only, the findings observed cannot be generalised to languages outside of English. Additionally, in the case of both experiments, only monolingual speakers were tested. Research into bilingualism provides evidence to believe that the language brains of monolingual and bilingual speakers are different. Therefore, the findings from the present research are also unable to be generalised to bilingual speakers. If the findings on decomposition are only applied to monolingual, English speakers, these findings can only account for only 400m speakers (0.05%) of the world's population, however, it can also account for approximately 95% of the British population.

6.4 Implications for further research

Experiment 1 and Experiment 2 both supported the idea that morphologically complex words are decomposed into their component morphemes for recognition. Prior research, mentioned in Section 2.1 (Taft et al, 1986) notes that prefixed words have the potential to be recognise faster than suffixed words in a lexical decision task, due to words in English being read from left to right. Therefore, further research could investigate this further put prefixed words and suffixed words together in a lexical decision task, to determine which elicits the faster response time.

Although it cannot be disregarded for certain that there are regions undetected in this study which also may contribute to morphological processing, the current findings from the present research are consistent with the claim that morphology emerges from the convergence of form and meaning, as previously investigated. Important questions still remain, however. For instance, additional studies will be necessary to determine whether the same pattern of results are seen for auditory word pairs sharing phonological form, word pairs sharing inflectional and derivational morphology, and languages such as Turkish or Hebrew with their richer morphological structure.

It is also not the case that not all languages require words to be read from left to right. Therefore, further research could also be conducted into the mental storage of morphology in other languages, specifically languages where subjects are required to read from right to left.

Rastle, Davis, Marslen-Wilson & Tyler (2000) looked at morphological, semantic and orthographic priming using a masked priming technique. They found that the effects of morphologically related, semantically transparent primes (e.g. hunt-hunter) were greater than those found for purely semantically related primes, (e.g. cello-violin). Potential further research could additionally investigate the effect of morphologically related, semantically opaque primes.

It has been mentioned thatthe profession of the participant couldbe a determining factor for which words will be responded to quicker in a lexical decision task. Words to do with people's professions could result in a higher resting activation level in the mental lexicon, as a result of them being used by the individual frequently.This would elicit a faster response time for the 'profession related words' than normal or 'everyday' words. Further research could focus on how people's lifestyles and/ or career choices might provide an insight into the individual differences in individuals' mental lexicon.

Whilst writing the Literature Review section of this paper it became apparent that the majority of research surrounding the topic of morphological decomposition of affixed words was conducted via a highly controlled lab method. This raises the question of whether or not the findings provide an accurate depiction of lexical representation in every day speech, or if they are only apparent under experimental conditions. Further research to address the debate regarding how variables such as orthography or frequencyinteract with recognition of complex words could be conducted in a more naturalistic environment. However, it is recognised that it proves difficult to isolate one's word choices and control for cause and effect whilst being discrete. However, this may be considered for future research.

7. Appendix

7.1 Items for Experiment 1

Transparent affixed test words:kiddie; sweetie; doggie; birdie; cutie; farmer; fighter; hunter; writer; dancer; careful; joyful; truthful; useful; skillful

Opaque affixed test words: foodie; bookie; hippie; goalie; brownie; blooper; poster; bumper; sweater; officer; grateful; eyeful; bashful; fruitful; artful;

Fillers including nonwords:

wait; bist; tilful; chair; vasc; puthful; gorilla; moof; datful; glomp; yanful; board; pulf; pyeful; coat; bunp; gopful; fish; clob; bipful; drink; dait; sogful; play; roap; procker; house; woard; smarler talk; slud; gancer; blick; doster; blue; nair; piter; stick; stim; wumfer; carrot; blost; foder pencil memp; pimer

7.2 Accuracy ratings for Experiment 1

PP	C W1	C W2	I W1	I W2
1	96.15385	100	93.10345	96.55172
2	100	96.2963	93.33333	96.66667
3	100	100	100	100
4	100	100	100	100
5	96.42857	100	96.42857	96.42857
6	100	100	100	96
7	86.66667	86.66667	90	96.66667
8	93.10345	100	86.2069	100
9	100	100	100	100
10	100	100	100	96
11	92	100	81.48148	88.88889
12	100	100	100	100
13	100	100	96.42857	96.42857
14	89.28571	92.85714	70.37037	92.59259
15	100	96.55172	100	96.15385
16	96.66667	100	90	93.33333
17	92.85714	96.42857	79.31034	89.65517
19	92.85714	100	93.33333	96.66667
19	100	100	86.95652	95.65217
20	95.83333	100	95.65217	95.65217
21	100	100	95	95
22	100	100	96.55172	100
23	100	100	100	100
24	82.75862	96.55172	88.88889	100
25	92.30769	100	91.66667	91.66667
26	100	100	100	100
27	96.2963	100	95.45455	100
28	96.66667	100	92.59259	100
29	93.33333	100	96.55172	96.55172
Average	96.31776	98.80525	93.42452	96.77777

7.3 Items for Experiment 2

<u>High frequency stem test words:</u>

fearful; graceful; manager; dancer; playful; runner; youthful; driver

<u>Low frequency stem test words:</u>

baker; boastful; commuter; delightful; factful; frightful; looter; painter

Fillers including nonwords:

wait; bist; tilful; chair; vasc; puthful; gorilla; moof; datful; glomp; yanful; board; pulf; pyeful; coat; bunp; gopful; fish; clob; bipful; drink; dait; sogful; play; roap; procker; house; woard; smarler talk; slud; gancer; blick; doster; blue; nair; piter; stick; stim; wumfer; carrot; blost; foder pencil memp; pimer

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