NANYANG TECHNOLOGICAL UNIVERSITY

SCHOOL OF HUMANITIES AND SOCIAL SCIENCES

Comprehending Words in Context:
A reaction-time study of lexical ambiguity resolution

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Abstract

Psycholinguistic research on semantic processing commonly distinguishes bottom-up lexical processes – involving the automatic retrieval of word senses stored in memory – from top-down contextual processes – involving the active imposition of situational constraints on the construal of lexical items (*e.g.* Andrews & Bond 2009). Extensive studies, since the 1970s, have sought to ascertain whether these two processes are largely autonomous mechanisms or interlinked sub-processes of a single mechanism. This has led to the proposal of three influential models of word processing – namely, the DIRECT ACCESS MODEL, the AUTONOMOUS ACCESS MODEL, and the REORDERED ACCESS MODEL – which critically differ in the extent to which they consider these two processes as largely interrelated or independent. Most recently, two studies (Peleg et al. 2001; 2008) claimed to have found compelling evidence disconfirming the DIRECT ACCESS MODEL and supporting the AUTONOMOUS ACCESS MODEL. The current study suggests theoretical and experimental reasons to doubt the above conclusion, and presents the results of counter-experiments which challenge the AUTONOMOUS ACCESS MODEL and support the REORDERED ACCESS MODEL instead.

Sixty native English speakers completed a series of timed lexical decisions across two experiments. In Experiment 1, each lexical decision probe was preceded by a priming passage which ended with a disambiguated homonym, to which it was either contextually-related or contextually-unrelated. In Experiment 2, each lexical decision probe was preceded by the same passages, except that the final homonym was omitted. A statistical analysis of participant reaction-times showed that lexical decision rates were significantly faster for contextually-relevant probes than contextually-irrelevant probes in Experiment 1 but not in Experiment 2, indicating that the homonym was crucial to the priming effect of these passages. Specifically, it demonstrates that prior context affected the semantic processing of these homonyms, which thereafter primed associated probes. Accordingly, this finding is problematic for the AUTONOMOUS ACCESS MODEL but fully consistent with the REORDERED ACCESS MODEL.

1. Introduction

"if a speaker is to be able to assign a meaning to every sentence of his language, the principles he uses must obtain the meaning of a compound construction as a compositional function of the meanings of its constituent parts … this construction must start with the meanings of the elements that are taken as atomic in syntactic descriptions, i.e., with the words. Hence, the semantic rules must include *a dictionary in which each word of the language is associated with a representation of its meaning* … Accordingly, a dictionary is a finite list of dictionary entries, one for each word in the language. A dictionary entry consists of a word paired with a representation of its meaning *that includes every piece of information required* for the projection rules to operate properly."

– Jerrold Katz (1964: 742)

"a speaker's entire apprehension of the context (including its discourse and interactional dimensions) constitutes the basis for linguistic meanings, with any facet of the context having the potential to be evoked as part of an expression's actual semantic value … *lexical items do not in general have fixed or well-delimited meanings* … [instead they give] access to a large inventory of cognitive domains … in a flexible, open-ended manner as determined by context and speaker concerns … With every use, moreover, *an element accommodates to the context and to the elements it co-occurs with*. As they recur, variants produced by these adjustments undergo progressive entrenchment and conventionalization. This results in complex categories comprising multiple variants, whose selection on a given occasion is also subject to negotiation and contextual determination."

– Ronald Langacker (1997: 235-237)

1.1. Theories of lexical semantics

To what extent is the meaning of a word in a given utterance *retrieved* from the mental lexicon of language users <u>and</u> *constructed* within the context of its expression? Given that users of a language have to learn its words, it appears undeniable that for every occasion of a word's use certain expectations about its semantic content must exist, as the quote from Katz underscores.[1] However, as Langacker's quote emphasizes, the precise semantic contribution of a word embedded in natural discourse crucially depends on the particular communicative context in which it occurs. For example, consider the meaning of *safe* in the following sentences:[2]

[1] a. This room is child-safe.
b. This beach is shark-safe.
c. This tuna is dolphin-safe.

While [1a] refers to a room where *children are safe* from dangers they are commonly vulnerable to, [1b] refers to waters off a beach where people can swim *safe from shark attacks*, whereas [1c] refers to tuna caught using fishing methods designed with *safeguards for dolphins*.

[1] *Cf.* Barsalou's (1982) discussion of context-independent and context-dependent information in concepts.
[2] Examples adapted from Turner and Fauconnier (1995).

Thus, Evans and Green (2006: 161-162) argue that such examples "illustrate that there is no single fixed property that *safe* assigns to the words" *child*, *shark* and *dolphin*.[3] "In order to understand what the speaker means, we draw upon our encyclopaedic knowledge relating to" children, sharks and dolphins, "and our knowledge relating to what it means to be safe. We then 'construct' a meaning … that is appropriate in the context of the utterance."

Consequently, recent attempts within the cognitive-functional linguistics tradition to reconcile both the stored and situational facets of word meanings have led to a new perspective on lexical semantics, which views the *conventionally associated senses* of particular words as impoverished or underspecified semantic prompts for their *contextually realized meanings*, which are constructed on the fly (Radden et al. 2007). On this account, individual words do not, in and of themselves, have predetermined meanings (Taylor 2006). Rather, the protean meanings of words necessarily *emerge* out of the interaction between their 'meaning potential'[4] (formed from the memory of past usages) and the constraints of the immediate context in which they occur (Allwood 2003; Zlatev 2003; Evans 2006; 2009; Harder 2010; see also LaPolla 2015 and Frisson 2009 for similar conclusions drawn from linguistic typology and psycholinguistic studies respectively). But in order to understand *how* these two factors exactly interact – as cognitive processes – it is necessary to turn to the literature on language processing.

1.2. Models of lexical processing

Fittingly, psycholinguistic research on semantic processing has similarly distinguished between *bottom-up* lexical processes – involving the automatic retrieval of word senses stored in memory – from *top-down* contextual processes – involving the active imposition of situational constraints on the construal of lexical items (*e.g.* Andrews & Bond 2009). Since the 1970s, extensive attempts to clarify the relationship between these two processes have centred on ascertaining their degree of demonstrable interrelatedness/independence: are they largely separate, autonomous mechanisms or interlinked sub-processes of a single, holistic mechanism? Crucially, experimental studies examining the real-time processing of **ambiguous**[5] words –

[3] This is both a criticism of the traditional view of word meaning and, more fundamentally, the classical theory of concepts – as definable in terms of necessary and sufficient conditions – in Western philosophy. An influential earlier criticism from within philosophy is Wittgenstein (1953).
[4] Allwood (2003: 43) defines a word's 'meaning potential' as "all the information that the word has been used to convey either by a single individual or, on the social level, by the language community".
[5] This refers to homonymous words with two or more distinct senses. For a theoretical discussion on the differences and continuity among lexical vagueness, polysemy and ambiguity/homonymy, see Tuggy (1993).

specifically the extent to which a prior disambiguating context can constrain or facilitate access to various senses of a homonym – have provided an important avenue into this inquiry (Simpson 1984). Notably, such investigations have led to the proposal of three influential models of word processing, which critically diverge in their views as to whether contextual constraints directly interact with lexical access, and thus whether contextual and lexical processes work as (a) joint or separate mechanism(s).

1.2.1. Direct Access Model

Under this model, lexical and contextual processes are closely interlinked and operate as a single mechanism. When following a disambiguating context of sufficient constraint, the situationally relevant sense of an ambiguous word can be *selectively retrieved*, as context can inhibit the retrieval of irrelevant senses during the lexical process (Simpson 1981; Kellas et al. 1991; Martin et al. 1999; Vu, Kellas & Paul 1998; Vu et al. 2000). This model assumes a **strongly interactive** view of human cognition, and predicts that lexical sense access can be *directed* by sufficiently constraining contexts, as both processes interact and work jointly (McClelland 1987).

1.2.2. Autonomous Access Model[6]

Under this model, lexical and contextual processes are completely independent and operate as distinct mechanisms. When following a disambiguating context of any degree of constraint, all salient senses of an ambiguous word will be *exhaustively retrieved*, as context cannot inhibit the retrieval of irrelevant senses during the lexical process, but merely guides the rapid integration of the situationally relevant sense into the running discourse, after lexical retrieval has been completed (Swinney 1979; Onifer & Swinney 1981; Seidenberg et al. 1982; Peleg, Giora & Fein 2001; 2008). This model assumes a **modular** architecture of mind, and predicts that lexical sense access is *impervious* to contextual constraints, as both processes do not directly interact and work separately (Forster 1979).

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[6] Technically, context-insensitive models of word processing can be divided into two types: i) **simple exhaustive models** (*e.g.* Tanenhaus, Leiman & Seidenberg 1979; Onifer & Swinney 1981), which predict that all senses of an ambiguous words encountered will be activated to the same degree, regardless of their frequency of occurrence (*i.e.* sense dominance), and ii) **ordered/salience-based models** (*e.g.* Hogaboam & Perfetti 1975; Peleg, Giora & Fein 2001; 2008), which predict that all senses of an ambiguous word will be activated to varying degrees, relative to their frequency of occurrence (*i.e.* dominant/subordinate). Both types are treated as variants of the autonomous access model here, since they view context as interacting only with the output of the lexical process, not directly with the retrieval of lexical senses.

1.2.3. Reordered Access Model

Under this model, lexical and contextual processes are interrelated but operate as differentiable – although not autonomous – mechanisms. When following a disambiguating context of any degree of constraint, all salient senses of an ambiguous word will be *exhaustively retrieved*, as context cannot inhibit the retrieval of irrelevant senses during the lexical process; however, a sufficiently constraining prior context may immediately boost activation of the situationally relevant sense during the lexical process itself (Duffy, Morris & Rayner 1988; Dopkins, Morris & Rayner 1992; Sereno 1995; Binder & Rayner 1998; Rayner, Binder & Duffy 1999). This **hybrid** model predicts that lexical sense access may be *influenced but not directed* by contextual constraints, as the workings of both processes are neither completely separate nor conjoint (Rayner, Pacht & Duffy 1994).

1.2.4. Comparison of Models

Altogether, the above models can be placed along a continuum ranging from interlinked to independent processing of lexical senses and contextual constraints (see Figure 1 below), yet they can also be dichotomized in two different ways. Firstly, with respect to whether contextual constraints can selectively activate specific senses of an ambiguous word, the direct access model (yes) stands alone against the reordered and autonomous access models (no). Specifically, in the direct access model, context may serve to *restrict* access to inappropriate senses of a homonym, while in the reordered access model, context *resolves* selection of a homonym's appropriate sense among activated candidates, and in the autonomous access model, context is merely what the appropriate sense of a homonym is *integrated* into at the sentential/discourse level. Secondly, with respect to whether contextual constraints can directly influence the initial access of lexical senses, the autonomous access model (no) stands alone against the reordered and direct access models (yes). Specifically, under the autonomous access model lexical and contextual processing are separately encapsulated operations, whereas the reordered and direct access models view both processes as interactively connected to some degree.

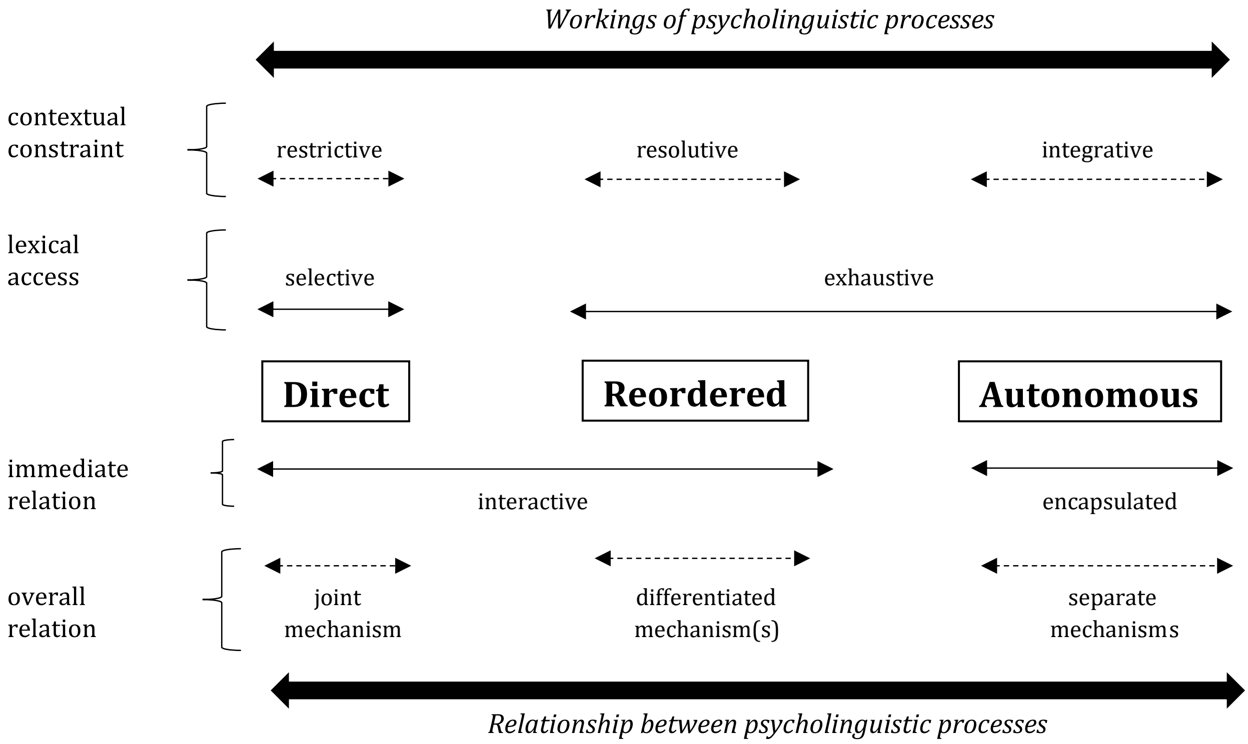

Figure 1: Comparative summary of three models of word processing

1.3. Experimental research on lexical ambiguity

<u>1.3.1. Previous studies</u>

Pioneering research on lexical ambiguity processing favoured the AUTONOMOUS ACCESS MODEL (Swinney 1979; Onifer & Swinney 1981). These studies argued that when participants listen to passages containing a homonym disambiguated by prior context (*e.g.* use of "bug" to mean 'microphone'), they nonetheless activate both the appropriate and inappropriate senses of the ambiguous word (*e.g.* 'microphone' and 'insect' senses of "bug"). This was evidenced by their faster response times in deciding whether a probe word – visually presented to participants immediately after they listened to the ambiguous word – existed in the language, when the probe was semantically related to the inappropriate sense of the homonym (*e.g.* "ant") than when the probe was semantically unrelated to either senses of the homonym (*e.g.* "sew"). Further, such priming of the inappropriate sense disappeared when the lexical decision probe was presented to participants 1.5 seconds after they listened to the ambiguous word (Onifer & Swinney 1981).[7] These findings were taken as evidence that lexical sense retrieval operates

[7] The literature refers to this as the inter-stimulus interval (ISI) – essentially the delay between presentation of the priming stimuli and the subsequent probe stimuli in these studies (*cf.* footnote 10).

autonomously of contextual constraints: a homonym's senses are (always) exhaustively accessed, before (prior) context rapidly suppresses the inappropriate senses.

But this conclusion was subsequently challenged by research favouring the DIRECT ACCESS MODEL (Simpson 1981; Kellas et al. 1991), which varied disambiguating/priming contexts by degree of constraint [strong *vs* weak] and targeted homonym senses by degree of frequency [dominant *vs* subordinate]. Using the same primed lexical decision paradigm, these studies argued that when *either* sense of a homonym was disambiguated by a *strong* preceding context, participants accessed only that (appropriate) sense of the homonym. This was also true when the *dominant* sense of a homonym was disambiguated by a *weak* preceding context. Only when the *subordinate* sense of a homonym was disambiguated by a *weak* preceding context was evidence of multiple access of lexical senses obtained. These findings indicated that context – when sufficiently constraining – can direct lexical sense retrieval: only when contextual constraints weakly bias a homonym's relatively less frequent sense (*e.g.* 'microphone' as opposed to 'insect' sense of "bug") do participants activate multiple senses, conjuring an image of exhaustive access.

However, the aforementioned studies were challenged by eye-movement research, which used gaze duration on a target word as a measurement of lexical processing complexity (Schustack, Ehrlich & Rayner 1987), and further differentiated *balanced* homonyms – which have equally common senses – from *biased* homonyms – in which one sense is dominant and the other subordinate in frequency/salience. These latter studies (Duffy, Morris & Rayner 1988; Rayner, Pacht & Duffy 1994; Binder & Rayner 1998) found that participants gazed significantly longer at *biased* homonyms disambiguated by prior contexts favouring their *subordinate* sense – compared to both *balanced* homonyms disambiguated by prior contexts favouring either of their senses, and *unambiguous* control words – even when prior context was strongly constraining. Rayner et al. (1994) argued that this finding – which they labelled the **subordinate bias effect** (SBE) – was <u>incompatible with the autonomous access model</u>, which would predict similar processing times for both biased and balanced homonyms, since their senses would be exhaustively accessed without regard for prior disambiguating context. Further, Rayner et al. (1994) found that the SBE was not diminished by repeated instantiations of a homonym's subordinate sense across a passage. They argued that this was <u>incompatible with the direct access model</u>, which would predict that repeated activation of this subordinate sense should grow less effortful, as contextual constraint increases with accumulation.

Altogether, these findings were taken as evidence supporting the REORDERED ACCESS MODEL, which – like the autonomous access model – predicts that all salient senses of an ambiguous word are exhaustively retrieved when encountered (hence the persistence of the SBE despite repeated instantiations), yet also – like the direct access model – predicts that prior disambiguating context can influence the activation of the appropriate sense during the lexical process itself (hence the occurrence of the SBE for biased but not balanced homonyms). Importantly, the reordered access model emphasizes that activated senses subsequently compete for selection in a "horse-race" of sorts, with *both sense frequency and contextual constraints augmenting the relative ease for a particular sense to be selected* (Rayner, Binder & Duffy 1999: 846). When preceded by a neutral context, balanced homonyms are more difficult to process than biased homonyms, because the equally frequent senses of balanced homonyms display comparable levels of activation and vigorously compete for selection, whereas the more highly activated dominant senses of biased homonyms are rapidly selected over their less highly activated subordinate senses. However, disambiguating context preceding a homonym can boost the activation of a particular sense during lexical processing, and, in the particular case when it favours the less frequent sense of a biased homonym, that previously subordinate sense is temporarily heightened to such a level of activation that it now vigorously competes with the dominant sense for selection, resulting in longer processing times that is the SBE.

Additionally, Rayner et al. (1999: 848) suggested that earlier studies supporting the direct access model suffered from two deficiencies. First, they used a self-paced reading procedure[8] that allowed participants "to spend as long as they wanted on an ambiguous word", which likely permitted the selection of appropriate homonym senses from exhaustively retrieved candidates prior to the lexical decision task. Second, their materials were problematic.[9] Nonetheless, later studies using the naming latency paradigm have defended the DIRECT ACCESS MODEL, by obtaining evidence for selective access even when the presentation rate[10] of the homonym was fixed at 80-msec and revised materials were used (Vu, Kellas & Paul 1998; Vu et al. 2000). These studies affirmed that when meticulously constructed contexts were employed, the SBE and evidence of multiple lexical sense access could be eliminated.

[8] In the self-paced reading procedure, participants are presented linguistic stimuli one word at a time, at a rate controlled by them: each subsequent word is displayed after they press a key.
[9] The complicated details of this critique are presented at length in Binder and Rayner (1999).
[10] The literature refers to this as the stimulus onset asynchrony (SOA) – essentially the exposure duration of the ambiguous prime in these studies (*cf.* footnote 7).

Most recently, two studies supporting the AUTONOMOUS ACCESS MODEL have offered particularly compelling evidence disconfirming the direct access model (Peleg, Giora & Fein 2001; 2008), by reusing the same materials in the Vu et al. studies with minor amendments. Crucially, Peleg et al. (2008) argued that evidence favouring selective rather than exhaustive access was obtained because participant reaction times were compared against *control probes* rather than *control stimuli*. For example, Vu et al. (2000) submitted evidence of selective homonym sense retrieval following a disambiguating discourse context, by showing that participants verbally named probe words – presented immediately after they read sentence-pairs ending with an ambiguous word (such as [2] below) – significantly faster if the probe was related to the relevant sense of the homonym (*e.g.* "microphone" after [2]) than if the probe was either related to the irrelevant sense of the homonym (*e.g.* "insect" after [2]) or an unrelated control word (*e.g.* "station" after [2]). However, when Peleg et al. (2008) constructed a control stimuli by replacing the homonym with an unambiguous associate (such as [3] below), they found that lexical decision times on the same probe (*e.g.* "insect") were significantly faster following contextually-irrelevant *but semantically-related* stimuli (after [2]) than contextually-irrelevant *and semantically-unrelated* stimuli (after [3]). This was taken as evidence that despite strong contextual constraints, an irrelevant but dominant sense of a homonym was still accessed (although at a lower level of activation than the relevant sense), contrary to the predictions of the direct access model.

[2] The detective searched the room. He spotted a <u>bug</u>*

< Probes displayed at *: relevant/subordinate–microphone; **irrelevant/dominant–insect**; unrelated–station >

[3] The detective searched the room. He spotted a <u>microphone</u>*

< Probes displayed at *: **unrelated–insect** >

[NB: **bold**/non-bold probes in (2) used by Vu et al. (2000); **bold** probes across (2) and (3) used by Peleg et al. (2008)]

Further, Peleg et al. (2001) argued that evidence appearing to support direct lexical access in fact reflected the predictive effects of top-down contextual processes, which did not actually interact with bottom-up lexical processes. For example, Vu et al. (1998) submitted evidence of selective homonym sense retrieval following a disambiguating sentential context, by showing that participants verbally named probe words – presented immediately after they read sentences ending with an ambiguous word (such as [4-5] below) – significantly faster if the probe was related to the relevant sense of the homonym, than if the probe was either related to the irrelevant sense of the homonym or an unrelated control word. However, when Peleg et al. (2001) replicated the experiment, but presented the probes *before* the onset of the homonym, they obtained the same findings. Peleg et al. (2001) concluded that rather than context directing lexical activation of only the relevant homonym sense, and thereafter priming subsequent semantically-associated probes, context facilitated predictive inferencing of the appropriate homonym sense in advance.

[4] The slugger splintered the** bat*
< Probes: relevant/dominant–wooden; **irrelevant/subordinate–fly**; unrelated–station
Vu et al.'s (1998) probes displayed at *, Peleg et al.'s (2001) probes displayed at ** >

[5] The biologist wounded the** bat*
< Probes: relevant/subordinate–fly; **irrelevant/dominant–wooden**; unrelated–station
Vu et al.'s (1998) probes displayed at *, Peleg et al.'s (2001) probes displayed at ** >

Altogether, Peleg et al. (2001; 2008) contend their findings – particularly the inability of context to inhibit irrelevant but dominant homonym senses – support a salience-based version of the AUTONOMOUS ACCESS MODEL (Giora 1997), in which senses associated with a lexical item are ordered by salience, while lexical and contextual processing operate as separately encapsulated mechanisms, as context can facilitate prediction of upcoming senses but cannot directly influence the lexical sense retrieval process. However, scrutiny of Peleg et al.'s (2001; 2008) studies reveal that convincing evidence has only been found for lexical sense retrieval not being selective, not for lexical processing operating autonomously of contextual constraints, for which both theoretical and experimental reasons can be presented.

It is theoretically possible that a strong context (such as in Vu et al. 1998; Peleg et al. 2001) might *both* prime relevant concepts (to which a probe is associated) in advance *and* directly influence the lexical processing of a subsequently encountered homonym. Indeed if context never interacts with the lexical retrieval process itself, one wonders how the salience-based ordering of dominant/subordinate homonym senses that Peleg et al. endorses would even arise – since an obvious explanation for its origins is that one sense was more frequently selected across various contexts of use relative to another, and this usage pattern became entrenched in semantic memory over time as polarized homonym senses (Langacker 2008). It is also worth noting that when Peleg et al. (2001) experimentally tested the ability of context to facilitate predictions of upcoming senses – *before* processing of lexical ambiguity occurred – they selected the strongest **local/sentential** contexts from Vu et al.'s (1998) materials; but when Peleg et al. (2008) tested for the inability of context to inhibit irrelevant but dominant homonym senses, they selected weaker **global/discourse** contexts from Vu et al.'s (2000) study.

Therefore, it is possible the latter contexts might not have been strong enough to facilitate prediction of upcoming senses, while still priming greater activation of the relevant sense of a subsequently encountered homonym (without inhibiting irrelevant senses). If so, this would be problematic for Peleg et al.'s (2001; 2008) modular view of language processing, in which contextual processing is walled off from lexical processing. Significantly, this alternative interpretation of Peleg et al.'s (2001; 2008) findings would favour the REORDERED ACCESS MODEL – which appears more probable, given that Rayner et al.'s (1994) SBE challenge against the autonomous access model has not been addressed.

1.3.2. The present study

As such, the current study sought to adjudicate between the REORDERED and AUTONOMOUS ACCESS MODELS, using Vu et al.'s (2000) discourse context materials – in view of the above – and Peleg et al.'s (2001; 2008) lexical decision methodology – given that explicit support for the reordered access model has traditionally been limited to eye-movement research (as in studies by Rayner and colleagues). To reiterate, the two models can be distinguished by their differing interpretations of Vu et al.'s (1998; 2000) empirical findings: after encountering a homonym whose interpretation is biased by prior context, language users respond faster to probe words that are semantically-associated to the situationally-appropriate than situationally-inappropriate sense of the homonym. According to the REORDERED ACCESS MODEL, this is *primarily* because prior context facilitates lexical processing of the appropriate sense of the homonym, by boosting its level of activation: it is the disambiguated homonym (its contextually-relevant sense) which primes faster reactions to *semantically-associated* probe words in a subsequent reaction-time task. But according to the AUTONOMOUS ACCESS MODEL, this is *entirely* because prior context enables predictive inferencing of relevant upcoming concepts itself, without affecting the lexical processing of the homonym: it is prior contextual constraints which directly prime faster reactions to *conceptually-related* probe words in a subsequent reaction-time task.

In other words, the models critically differ as to whether they view the disambiguated homonym as the locus of the priming effects. Therefore, if evidence can be obtained that Vu et al.'s findings *are not replicated* when the above described probe words are presented before the occurrence – and thus processing – of the homonym, this would favour the REORDERED ACCESS MODEL. Conversely, if evidence can be obtained that Vu et al.'s findings *are replicated* when the above described probe words are presented before the occurrence – and thus processing – of the homonym, this would favour the AUTONOMOUS ACCESS MODEL. Experiment 1, which attempted to replicate Vu et al.'s (2000) findings using Peleg et al.'s lexical decision procedure (2001; 2008), was designed to show that probe words were responded to faster if they were preceded by semantically-associated rather than semantically-unassociated homonyms disambiguated by prior context. Experiment 2, which attempted to challenge Peleg et al.'s (2001) conclusion by using material from Vu et al.'s (2000) study instead, was designed to rule out the possibility that faster reaction-times to contextually-relevant probe words was due principally to prior contextual constraints **biasing reader predictions of upcoming concepts**, which *directly primed conceptually-related probes*, rather than it being due to prior contextual constraints **biasing immediate interpretations of the aforementioned homonyms**, which *subsequently primed semantically-associated probes* – by omitting such homonyms from the presented/'priming' material. Together, both experiments aimed to show that contextual constraints can directly influence the lexical processing of subsequent words, and thus that contextual processing is intertwined with lexical processing in language comprehension, rather than being a strictly functionally-separate and sequentially-secondary mental operation.[11]

2. General Methodology

2.1. Participants

Sixty Singaporean speakers of English, aged 19-26 years (M = 22.05, SD = 1.71), took part in this study. To ensure participants shared comparable levels of English fluency and familiarity, only university undergraduates who spoke English as a home language were recruited. All participants were reimbursed 10 SGD for their involvement.

2.2. Material

Forty-eight passages adapted from Vu et al. (2000), each ending with a homonym whose interpretation was biased towards its subordinate/less salient sense, formed the critical (priming)

[11] By "functionally-separate" I mean to highlight the notion of lexical and contextual processing mechanisms being "**encapsulated**" mental operations in the autonomous access model's modular view of language processing. By "sequentially-secondary" I mean to highlight the view of contextual processing as occurring chronologically *after* the workings of lexical processing/sense retrieval, as communicated by the term "**post-lexically**" frequently used by supporters of the autonomous access model.

stimuli for this study. Following the presentation of each critical passage, a lexical decision probe [valid word] related to either the passage-final homonym's *relevant subordinate sense* [context-appropriate condition] or *irrelevant dominant sense* [context-inappropriate condition] was displayed.

The critical stimuli were split into two main blocks of 24 passages each. While participants 1-30 read **critical stimulus block 1** in Experiment 1 and **critical stimulus block 2** in Experiment 2, participants 31-60 read **critical stimulus block 2** in Experiment 1 and **critical stimulus block 1** in Experiment 2. Each critical stimulus block was further split into two sub-blocks of 12 passages each. In Experiment 1, participants 1-15 read **critical stimulus sub-block 1a**[12] in *context-appropriate condition* and **critical stimulus sub-block 1b**[13] in *context-inappropriate condition*, while participants 16-30 read the exact converse. Likewise, participants 31-45 read **critical stimulus sub-block 2a**[14] in *context-appropriate condition* and **critical stimulus sub-block 2b**[15] in *context-inappropriate condition*, while participants 46-60 read the exact converse. In Experiment 2, participants read the other stimuli block (1/2), while the sub-block division (a/b) within each block of experimental material was similar. Figure 2 below summarises the complete allocation of the study's critical stimuli, for all participant groups, across both experiments.

Stimuli (48x)	Passages: № 1 – № 48			
Blocks (2x)	Block 1: № 1 – № 24		Block 2: № 25 – № 48	
Sub-blocks (4x)	Block 1a: № 1 – № 12	Block 1b: № 13 – № 24	Block 1a: № 25 – № 36	Block 2b: № 37 – № 48
Participants (60x)	Group I: #1 – #15 **Experiment 1** **context-appropriate**	Group I: #1 – #15 **Experiment 1** **context-inappropriate**	Group I: #1 – #15 **Experiment 2** **context-appropriate**	Group I: #1 – #15 **Experiment 2** **context-inappropriate**
	Group II: #16 – #30 **Experiment 1** **context-inappropriate**	Group II: #16 – #30 **Experiment 1** **context-appropriate**	Group II: #16 – #30 **Experiment 2** **context-inappropriate**	Group II: #16 – #30 **Experiment 2** **context-appropriate**
	Group III: #17 – #45 **Experiment 2** **context-appropriate**	Group III: #17 – #45 **Experiment 2** **context-inappropriate**	Group III: #17 – #45 **Experiment 1** **context-appropriate**	Group III: #17 – #45 **Experiment 1** **context-inappropriate**
	Group IV: #46 – #60 **Experiment 2** **context-inappropriate**	Group IV: #46 – #60 **Experiment 2** **context-appropriate**	Group IV: #46 – #60 **Experiment 1** **context-inappropriate**	Group IV: #46 – #60 **Experiment 1** **context-appropriate**

Figure 2: Summary of critical stimuli allocation for all participant groups across both experiments

[12] Annex B-1 lists the passages, and the probes presented after them, in this sub-block.
[13] Annex B-2 lists the passages, and the probes presented after them, in this sub-block.
[14] Annex B-3 lists the passages, and the probes presented after them, in this sub-block.
[15] Annex B-4 lists the passages, and the probes presented after them, in this sub-block.

The rationale for such fastidious divisions of experimental material was two-fold: i) to ensure all critical stimuli were presented across all four experimental conditions – so that any **variability in processing complexity** among individual passages affecting lexical decision times was evened out, and ii) to ensure participants never read the same stimuli across different experimental conditions – while also counterbalancing any **practice/order effects** affecting lexical decision times.

As the experiments reported in Vu et al. (2000) were conducted in a North American context, whereas the present study was carried out in a Singaporean context, cultural relevancy was the main criteria governing the selection and adaptation of critical stimuli from Vu et al. (2000). For example, passages which referenced exclusively American concepts – such as the use of 'reservation' to mean a Native American settlement [see (6) below] – were not selected, while English words not commonly used in the Singaporean context were replaced with more familiar counterparts – such as 'homesteader' with 'farmer' [see (7) below]. Additionally, the length of all passages was standardized for each experiment (see §3–4 for details).

[6] Not selected: The trader needed furs. He checked the **reservation**.

[7] Original: The homesteader needed a good crop. He wanted a **shower**.
Adapted: The farmer needed good crops. He wanted a **shower**.

Forty-eight additional passages adapted from Vu et al. (2000) formed the filler stimuli for this study. Following the presentation of each filler passage, a lexical decision probe [nonsense word][16] was displayed. The filler stimuli was split into two blocks of 24 passages each. While participants 1-30 read **filler stimulus block 1**[17] in Experiment 1 and **filler stimulus block 2** in Experiment 2, participants 31-60 read **filler stimulus block 2**[18] in Experiment 1 and **filler stimulus block 1** in Experiment 2. In total, each participant read 96 passages (and completed 96 lexical decisions) across the two experiments.

2.3. Apparatus

Stimulus presentation and response collection was controlled by an Intel Core i5 personal computer, using the OpenSesame 3.1.4 Jazzy James experimental program.

[16] Phototactically-plausible nonsense words were generated using an online program: http://soybomb.com/tricks/words/ [Accessed Jan 5, 2017].
[17] Annex C-1 lists the passages, and the probes presented after them, in this block.
[18] Annex C-2 lists the passages, and the probes presented after them, in this block.

2.4. Conduct

The study was conducted in three phases: Familiarization, Experiment 1, Experiment 2. Between phases, participants were given the choice of taking a break or moving on immediately with the next phase. During the familiarization phase, participants were presented with 16 practice passages and lexical decision probes in sequential order.[19] During each experimental phase, participants were presented with 48 passages and lexical decision probes in randomized order. Participants were tested individually in a quiet, privately-booked study room to minimize ambient distractions.

3. Experiment 1

Using a naming latency paradigm, Vu et al. (2000) found that after language users read a homonym whose interpretation was biased by prior context, they responded faster to probe words that were semantically-associated to the contextually-relevant rather than contextually-irrelevant sense of the homonym. The purpose of Experiment 1 was to replicate this empirical finding using the lexical decision paradigm. The motivation was two-fold: to provide methodological triangulation, and to provide Experiment 2 – which aimed to adjudicate between the REORDERED and AUTONOMOUS ACCESS MODELS using participant lexical decision times – with a basis for comparison. The decision to use the lexical decision paradigm for Experiment 2 (and hence Experiment 1) was in keeping with Peleg et al.'s (2001) methodology, whose conclusions in support of the AUTONOMOUS ACCESS MODEL this study sought to challenge.

3.1. Design

A 1 x 2 design was used with probe type (appropriate vs. inappropriate) as the within-subjects factor.

3.2. Stimuli

Participants were presented with 48 passages and lexical decision probes in randomized order: 24 were critical stimuli (passages followed by valid probe words), 24 were filler stimuli

[19] Annex A lists the passages, and the probes presented after them, in this block.

(passages followed by nonsense probe words). Among the critical stimuli (allocation as per Figure 2), 12 passages were followed by contextually-appropriate probes [*e.g.* (8) below] and the other 12 by contextually-inappropriate probes [*e.g.* (9) below].

[8] Passage: **The gambler wanted an ace. He searched the deck*** Probe: **pack**
[9] Passage: **The gambler wanted an ace. He searched the deck*** Probe: **ship**
< Probes displayed at * >

All passages consisted of an eight-word context plus a passage-final homonym. As the experiment was designed to test whether contextual constraints can affect the interpretation of subsequent words, all contextually-appropriate probes were related to the subordinate/'non-default' sense of the passage-final homonym, and hence all contextually-inappropriate probes were related to the dominant/'default' sense of the passage-final homonym.[20]

3.3. Procedure

Stimuli presentation followed a modified moving-window format[21] (Simpson et al. 1989), in which passages 'unfolded' across a computer screen, one word at a time (80-msec SOA),[22] from left to right. Each word remained visible until the whole passage was displayed. Thereafter, the passage was immediately replaced by a letter-string/probe displayed at screen centre (0-msec ISI), which remained visible until the participant made a lexical decision as to whether the letter-string/probe was a valid or nonsensical word in English by pressing one of two (yes/no) keys. Thereafter, the letter-string/probe was replaced by a 'Correct' or 'Error' feedback page based on the accuracy of the participant's lexical decision,[23] which remained visible until the participant pressed the 'next' key. The latency between the onset of each probe and its lexical decision keypress was recorded by the experimental program as participant reaction-times.

[20] With regards to how the dominant and subordinate senses of each homonym presented in this study were determined, see Vu et al. (1998).
[21] This procedure was used in both the Vu et al. (1998; 2000) and Peleg et al. (2001; 2008) studies.
[22] In keeping with Rayner et al.'s (1999) criticism of previous studies with substantial SOA durations possibly allowing participants enough time to select context-appropriate homonym senses *after* exhaustive lexical sense retrieval had occurred – and thus fail to give an accurate picture of contextually-altered lexical sense retrieval – an extremely conservative SOA rate of 80-msec/word was used for this study.
[23] Additionally, due to the number of lexical decisions participants had to complete, the feedback pages allowed participants to pause for whatever reason during the experiment proper (*e.g.* to take a sip of water, put on a jacket), as recording of their reaction-time would have ended/stopped for that lexical decision probe, while presentation of the next passage would have not yet begun.

Participants were instructed to read each passage completely, before completing the lexical decision task as rapidly as they can. Participants were also instructed to use their dominant hand's index finger for all keyboard presses, and to keep that finger above the 'next' key – which was equidistant from both lexical decision keys (yes/no) – while reading the passages. To ensure participants did indeed read the priming passages, they were required to pass a short offline quiz testing their recall of selected passages after the experiment, for their participation to be counted.

3.4. Results and Analysis

Reaction-times for all correct lexical decisions were averaged for each condition (contextually-appropriate vs. contextually-inappropriate). One participant was excluded because he failed the offline quiz assessing his recall of selected critical passages after the experiment (score < 33% correct). Table 1 below reports the mean reaction-times for each experimental condition and their standard deviations.

Condition	Mean	Standard Deviation
Contextually-appropriate	870.814	217.534
Contextually-inappropriate	889.064	234.569

Table 1: Mean reaction-times and standard deviations (in milliseconds) for Experiment 1

To test the hypothesis that reaction-times for the contextually-appropriate condition were significantly faster on average than those for the contextually-inappropriate condition, a paired sample *t*-test was performed. The results support the prediction: $t(58) = -1.763$, $p < .05$, one-tailed. The size of this significant difference, $d = -0.223$, also exceeded Cohen's (1988) convention for a small effect ($d = \pm.20$). Therefore, it is demonstrated that immediately after participants read passages ending with a homonym whose interpretation was biased by the preceding context, their average reaction-times to probe words that were semantically-associated with the contextually-appropriate sense of such homonyms were significantly faster than their average reaction-times to probe words that were semantically-associated with the contextually-inappropriate sense of such homonyms. Thus, the results of Experiment 1 replicate the findings of Vu et al. (2000), that prior context can prime faster reaction-times to subsequent contextually-relevant probes, using the lexical decision paradigm.

4. Experiment 2

The purpose of Experiment 2 was to adjudicate between the REORDERED and AUTONOMOUS ACCESS MODELS, which offer different explanations as to *how* the context passages which participants read in Experiment 1 caused them to subsequently react faster to contextually-relevant probes that were presented immediately after. As previously mentioned, the REORDERED ACCESS MODEL would contend this is *primarily* because <u>prior context facilitated lexical processing of the appropriate sense of the passage-final homonym</u>, which then primed faster reactions to *semantically-associated* probe words in the lexical decision task, whereas the AUTONOMOUS ACCESS MODEL would contend this is *entirely* because prior context <u>enables predictive inferencing of relevant upcoming concepts itself</u> – without affecting the initial lexical processing of the passage-final homonym – by directly priming faster reactions to *conceptually-related* probe words in the lexical decision task.

In other words, while the REORDERED ACCESS MODEL asserts that the passage-final homonym is *crucial* to the priming of faster participant reactions to contextually-relevant probes, the AUTONOMOUS ACCESS MODEL asserts that it is not. Therefore, Experiment 2 was designed to adduce evidence for the REORDERED ACCESS MODEL and against the AUTONOMOUS ACCESS MODEL, by showing that when the passage-final homonyms were omitted from the same passages first presented in Experiment 1, participants were no longer substantially primed to react significantly faster to the same contextually-relevant probes as compared to the same contextually-irrelevant probes.

4.1. Design

The design was the same as used in Experiment 1.

4.2. Stimuli

The stimuli distribution was the same as in Experiment 1 (allocation as per Figure 2). The sole difference was that all passages consisted of only the eight-word context, as the passage-final homonym was omitted. Examples [10] and [11] below illustrate critical passages followed by a contextually-appropriate probe and a contextually-inappropriate probe respectively.

[10] Passage: **The gambler wanted an ace. He searched the*** Probe: **pack**
[11] Passage: **The gambler wanted an ace. He searched the *** Probe: **ship**
< Probes displayed at * >

4.3. Procedure

The procedure was the same as used in Experiment 1.

4.4. Results and Analysis

Reaction-times for all correct lexical decisions were averaged for each condition (contextually-appropriate vs. contextually-inappropriate). Table 2 below reports the mean reaction-times for each experimental condition and their standard deviations.

Condition	Mean	Standard Deviation
Contextually-appropriate	901.527	265.267
Contextually-inappropriate	911.983	249.784

Table 2: Mean reaction-times and standard deviations (in milliseconds) for Experiment 2

To test the hypothesis that reaction-times for the contextually-appropriate condition were not significantly faster on average than those for the contextually-inappropriate condition, a paired sample *t*-test was performed. The results support the prediction: $t(59) = –0.555$, $p > .10$, one-tailed. Therefore, it is demonstrated that immediately after participants read the same passages as in Experiment 1, but with the final homonym omitted, their average reaction-times to probe words that were contextually-appropriate were not significantly faster than their average reaction-times to probe words that were contextually-inappropriate. Thus, the results of Experiment 2 indicate that the significantly faster reaction-times of participants to contextually-relevant (rather than contextually-irrelevant) probes in Experiment 1 was due to the *semantic association* of the relevant probes with the contextually-appropriate interpretations of the preceding passage-final homonyms, rather than the general *conceptual relatedness* of the relevant probes to the preceding context as a whole.

Therefore, the combined results of both experiments demonstrate that preceding contextual facilitation can directly influence the lexical processing of subsequent words – such as by boosting the contextually-appropriate sense of passage-final homonyms as in the case of Experiment 1 – and disconfirm the notion that preceding contextual facilitation can only enable predictive inferencing of upcoming concepts – as seen by the failure of the same experimental passages to prime significantly faster reactions to contextually-relevant probes in Experiment 2 when their final homonyms were omitted.

5. General Discussion

5.1. A hybrid model of word processing

Taken together, the overall findings of Vu et al. (1998; 2000), Peleg et al. (2001; 2008) and this study provide compelling grounds for adjudicating between the three models of word processing discussed in §1.2, and thus allow for more informed theorizing of the exact relationship between lexical and contextual processing in language comprehension. First, Vu et al. (1998; 2000) showed that prior context can immediately constrain the interpretation of subsequent words – by adducing evidence of faster participant reaction-times, following a homonym disambiguated by prior context, to probe words semantically-associated with its relevant sense compared to probe words semantically-associated with its irrelevant sense – thereby demonstrating that the bottom-up processing of (stored) lexical senses and the top-down processing of (situated) contextual constraints must interact at some point. This finding was replicated by the present study's first experiment.

Second, Peleg et al.'s (2008) second experiment showed that contextual constraints cannot inhibit the retrieval of situationally-inappropriate word senses – *i.e.* lexical sense retrieval is exhaustive – thereby demonstrating the relatively independent workings of lexical processes from contextual processes. Peleg et al. (2001) further suggested that contextual constraints do not directly interact with the lexical sense retrieval process *per se* – contextual and lexical processing are encapsulated from each other – rather, prior context may provide cues for language users to predictively infer upcoming concepts, which facilitates the discourse-level integration of subsequent contextually-congruent words. Peleg et al. (2001) argued that this was demonstrated by their first experiment's successful replication of Vu et al.'s (1998) results – that participants respond faster to probes semantically-related to the contextually-appropriate rather than contextually-inappropriate sense of preceding homonyms – even when those probes were displayed *before* the onset (and thus before the processing) of these homonyms. Peleg et al. (2001) asserted that their results suggest a reinterpretation of Vu et al.'s (1998) conclusion: rather than claiming that prior context constrained the initial interpretation of these homonyms

– by biasing the contextually-appropriate senses of these homonyms during lexical processing, which thereafter primed faster reactions to semantically-associated probes – prior context more likely primed faster reactions to subsequent contextually-relevant probes directly, without altering the lexical processing of these homonyms. Crucially, Peleg et al. (2001: 176-177; General Discussion) concluded that this reinterpretation was consonant with a modular account of language processing, in which lexical processing is encapsulated and impervious to contextual constraints, as it runs strictly in parallel to (*i.e.* never interacting with) contextual processing.

Third, the present study argues that Peleg et al.'s (2001; 2008) claim that lexical and contextual processing *never* directly interact was theoretically implausible. This is because many homonyms have polarized (*i.e.* dominant versus subordinate) senses, which very likely emerged from differences in the relative frequencies of their contexts of use, suggesting that previous contextual processes have some way of shaping later lexical processes. My study also contends that the results of Peleg et al.'s (2001) first experiment did not preclude the possibility that the strong **local/sentential** contexts used <u>both</u> enabled such predictive inferencing of upcoming concepts <u>and</u> altered/interacted with the lexical processing of subsequently encountered homonyms. Hence, I hypothesized that if less constraining **global/discourse** contexts were used instead, one might no longer observe such predictive inferencing of upcoming concepts, while still observing altered lexical processing of such homonyms. This was the motivation for the present study's second experiment, which adduced evidence in support of the above hypothesis, by showing that prior context can heighten the *initial* activation of typically less salient homonym senses over their typically more salient counterparts during lexical processing *without* predictively facilitating the processing of subsequent conceptually-related words.

In summary, the consolidated findings of the discussed studies indicate that, contrary to the DIRECT ACCESS MODEL, contextual constraints cannot direct the selective retrieval of appropriate lexical senses. This suggests that lexical and contextual processing do not operate as a single language processing mechanism but as differentiable mechanisms. Yet, contrary to the AUTONOMOUS ACCESS MODEL, contextual constraints can alter/reorder the lexical sense retrieval of subsequently encountered words, such as by *immediately* boosting the typically subordinate/less salient sense of an ambiguous word over its typically dominant/more salient sense. This suggests that lexical and contextual processing are not encapsulated operations but are able to interact during language processing. As such, the findings support the 'hybrid'

REORDERED ACCESS MODEL, which takes a middle ground between the other two models in theorizing lexical and contextual processing as differentiable but interactive operations in online language comprehension.

5.2. Methodological limitations and Future directions

5.2.1. Procedural rigorousness

With respect to experimental procedure, exceedingly conservative presentation rates of 80-msec SOA and 0-msec ISI were consistently used throughout this study. This ensured that the significantly different contextually-appropriate/inappropriate lexical decision times obtained in Experiment 1 could not be reasonably criticized as reflecting the rapid selection of relevant homonym senses *after* lexical processing had occurred, instead of the reordered/altered lexical processing of homonym senses *per se* (*cf.* Rayner et al. 1999). Further, while both Peleg et al. (2001; 2008) and this study used the lexical decision paradigm to obtain participant reaction-times, the present study took additional precautions in ensuring that participants used the same finger of their dominant hand for both 'yes' and 'no' responses, and that they rested that finger over a key that was equidistant from both the 'yes' and 'no' keys while reading the experimental passages prior to each lexical decision task.

One possible limitation of this study, however, is that participants were not formally assessed for differences in levels of English fluency and familiarity. Although participation was restricted to individuals who grew up speaking English at home (*i.e.* native speakers), it may be possible that non-uniform English proficiency among the participants might exert some effect on experimental reaction-times. Nonetheless, past studies do not suggest this to be a likely confound.

5.2.2. Methodological scope

With respect to methodological scope, both the context and probe stimuli were presented visually in this study. In view of the time-sensitive procedure employed, consistent presentation of experimental material in the same modality may have the advantage of sidestepping the relatively more complex attentional demands associated with a cross-modal setup (*cf.* Jolicoeur 1999). However, since the present study aims to advance the scientific understanding of semantic processing and lexical sense retrieval *in general*, subsequent research may seek to extend this study's findings to the auditory modality, such as by presenting *spoken* as opposed to *textual* stimuli.

5.2.3. Ecological validity

With respect to ecological validity, the visual presentation of experimental stimuli using a modified moving-window format (Simpson et al. 1989) – in which passages 'unfolded' across a computer screen one word at a time, with each word remaining visible until the whole passage was displayed,[24] – was designed to more closely mimic natural reading. This was in contrast to the more commonly used rapid serial visual presentation (RSVP) format (Potter 1984), in which each word is flashed at screen centre, with the next word replacing the previously displayed one.

Nonetheless, at least some researchers have raised a more fundamental criticism regarding the limitations of using behavioural methods to investigate online mental processing. In particular, such researchers argue that the involvement of participants in various experimental tasks – be it making a lexical decision or naming a word/picture – may generate unwanted mental processes (for example to create "subject strategies" to complete those tasks) which obscure the naturally-occurring processes (Swaab, Brown & Hagoort 2003: 341). Future research may therefore seek to corroborate the findings of the present study using neuroimaging techniques (*e.g.* fMRI, EEG, MEG) that allow for more naturalistic conditions, such as by not requiring participants to perform behavioural tasks like those mentioned above, since language users do not typically engage in these activities during everyday linguistic communication and comprehension.

5.3. Meaning in Language: Comprehension, Competition, Cognition

Importantly, the picture of semantic processing outlined by the reordered access model converges with the perspective of lexical semantics adopted by the cognitive-functional school of linguistics introduced at the beginning of this paper, in emphasizing the centrality of contextual constraints in the processing and emergence of meaning in language respectively. Linguistic meaning, according to cognitive-functional linguistics, is not a static property of

[24] Notably, the capacity to present experimental material in this more natural format was the main reason why the present study's experiments were developed using OpenSesame as opposed to E-Prime experimental software.

lexical items that is subsequently refined by contextual input, but a wholly emergent product of the interaction between a lexical item's 'meaning potential' – the cumulative memory of "all the information that the word has been used to convey" (Allwood 2003: 43) – and the constraints of the immediate context in which it occurs. The reordered access model is consonant with the above view, in holding that semantic processing involves the invariantly exhaustive retrieval of all conventional senses associated with a lexical item – but it is context which determines the activation levels of each competing sense from the very beginning: memory of past contexts of use establishes the salience-based ordering of dominant over subordinate lexical senses, although immediate context can alter this typical ordering of relative activation levels.

Further, both the reordered access model and cognitive-functional linguistics present accounts of language processing and linguistic organization which are grounded in mental processes that are generalizable across various domains of human cognition rather than being unique to language. Specifically, the reordered access model can be recognized as an instantiation of the more general *Competition Model* within psycholinguistics (MacWhinney 1987; Bates and MacWhinney 1989), in which language processing is understood in terms of the competition among activated lexical items for selection. In particular, the Competition Model attempts to provide a programmatic framework of language processing in terms of "the same basic principles that govern other aspects of cognitive processing" (MacWhinney 1987: 250). Strikingly, this concurs with the guiding ethos of cognitive-functional linguistics, which eschews theories of linguistic structure as reflecting markedly specialized cognitive principles rather than the workings of domain-general cognitive functions (Lakoff 1990), and thus asserts no principled boundary dividing *semantics* or 'linguistic meaning' from *pragmatics* or 'extralinguistic meaning' (Langacker 2008: 40). In bringing together these two complementary strains of research, this study offers a unified view of how meaning in language is both created and comprehended in context.

(7115 words)

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<u>Appendix A: Practice stimuli</u> (sequential presentation)

Passage	**Probe**
1. Welcome to the experiment. How fast can you read?	run
2. Each entry has two sentences. Nine words or less.	letters
3. No need to memorize. Just read through every word.	text
4. There will be a short quiz. After you complete.	affeliquake
5. Which you need to pass. To qualify for completion.	foggedate
6. It will be multiple choice. So not to worry.	feeling
7. Let's try some actual examples. And get a feel.	whorrid
8. The lifeguard scanned the pool. The swimmer had disappeared.	circulation
9. The collector inspected the marble. She noticed the chip.	incetss
10. The artist opened her sketch-pad. She drew a portrait.	surrise
11. The shopaholic saw the discount. He entered the shop.	goods
12. The student visited the library. She forgot the title.	furninte
13. The market was crowded. He worried about being pickpocketed.	wallet
14. The cinema was dark. She tripped over a step.	octobs
15. The jockey was racing. He was leading the pack.	multen
16. The tart was very sweet. She took another anyway.	portion

Appendix B-1: Critical stimuli sub-block 1a (randomized presentation)

Passage	Probe: appropriate / inappropriate
1. The reveller entered the room. She watched the ball.	dance / bounce
2. The traveller located a fungus. She investigated the bark.	tree / growl
3. The guard reported for duty. He patrolled the base.	camp / safe
4. The biologist searched the opening. He located the bat.	cave / ball
5. The judge was very lenient. He overlooked the battery.	assault / car
6. The undertaker applied the make-up. He touched the temple.	head / church
7. The vet examined its ear. He noticed the tick.	flea / clock
8. The detective searched the room. He spotted a bug.	microphone / insect
9. The queen ignored the warning. She dismissed the cabinet.	ministers / kitchen
10. The reviewer was disappointed. She hated the entire cast.	actors / broken
11. The commander counted the fatalities. He reviewed the charge.	attack / credit
12. The sailor shovelled the sand. He covered the chest.	treasure / body

Appendix B-2: Critical stimuli sub-block 1b (randomized presentation)

Passage	Probe: appropriate / inappropriate
13. The gambler wanted an ace. He searched the deck.	pack / ship
14. The kidnapper prevented the scream. He used the gag.	mouth / joke
15. The stage comedian was offensive. He noticed the glare.	stare / sun
16. The barmaid dropped the tray. She broke the glass.	cup / window
17. The guest decide to cheat. She hid her hand.	cards / fingers
18. The cabby knew the streets. He bypassed the jam.	stuck / toast
19. The activist pushed the agenda. He organized the lobby.	group / motel
20. The scientist transformed the data. He used a log.	calculate / wood
21. The bishop arrived on time. He held the mass.	catholic / weight
22. The scout searched his supplies. He found a match.	fire / together
23. The doctor examined the skin. She observed the mole.	pimple / rodent
24. The accountant subtracted the expense. He showed the net.	remainder / mesh

Appendix B-3: Critical stimuli sub-block 2a (randomized presentation)

Passage	Probe: appropriate / inappropriate
25. The guitarist adjusted the string. She changed the note.	tone / memo
26. The surgeon suspected some damage. He inspected the organ.	anatomy / piano
27. The caller won the contest. He received the pass.	ticket / football
28. The librarian found the quote. He marked the passage.	paragraph / route
29. The farmer hated the smell. He emptied the pen.	pig / write
30. The singer raised his voice. He changed the pitch.	key / throw
31. The screenwriter knew the lines. He recollected the play.	act / game
32. The husband roasted the chicken. He burned the pot.	pan / marijuana
33. The woman recalled her childhood. She preferred the present.	past / gift
34. The victim testified in court. He recognized the quack.	doctor / duck
35. The healer entered the chamber. He examined the ruler.	king / measure
36. The defendant listened in silence. She heard the sentence.	jail / grammar

Appendix B-4: Critical stimuli sub-block 2b (randomized presentation)

Passage	Probe: appropriate / inappropriate
37. The senior manager was flexible. He switched the shift.	timing / gear
38. The diabetic patient hated needles. He prevented the shot.	arm / gun
39. The farmer needed good crops. He wanted a shower.	rain / bath
40. The player wanted to trade. He offered the spade.	ace / shovel
41. The old shepherd was terrified. He dropped the staff.	pole / faculty
42. The agent was ecstatic. He had discovered a star.	movie / sky
43. The politician proposed the measure. He wrote the bill.	law / pay
44. The president started the argument. He divided the board.	directors / plank
45. The sportscaster announced the scores. He included the tie.	draw / bow
46. The bestman rehearsed his lines. He prepared the toast.	drink / bread
47. The animal felt an itch. He scratched his trunk.	elephant / car
48. The cardiologist found the problem. He repaired the vessel.	blood / navy

Appendix C-1: Filler stimuli block 1 (randomized presentation)

Passage	Probe: nonsense word
1. The alligator saw the food. He entered the river.	affoot
2. The chauvinist was truly obnoxious. He deserved the slap.	looncan
3. The groom stood up. He tugged the bent collar.	parede
4. The gardener dug a hole. She inserted the flower.	lumning
5. The harvester gathered the crop. He sold the fruits.	famity
6. The brewer started a company. She produced bottle caps.	tupacase
7. The shopper disliked the poem. She exchanged the cards.	proxid
8. The counsel left the room. He finished a lawsuit.	cartogy
9. The duchess accepted the gift. She knew the count.	boilley
10. The appraiser was skeptical. She measured the shiny crystal.	alogies
11. The graduate wanted a car. She saved the money.	romation
12. The yardman checked the weather. He foresaw the storm.	perped
13. The referee noticed the error. He checked the playback.	galarg
14. The beautician was not finished. She needed the file.	gative
15. The resident avoided the elevator. She used the stairs.	kafect
16. The opponent awaited the signal. He held the stance.	custing
17. The woodsman was hunting. He observed the sleeping tiger.	finize
18. The cook was thrifty. He saved the unused seasoning.	ematings
19. The poacher killed the rhino. He wanted its horn.	sniple
20. The traveller had few items. He wore no shoes.	sitisfies
21. The salesman lied about the product. He knew nothing.	absourusly
22. The zookeeper mixed the grain. He fed the yak.	detric
23. The pianist flipped the page. She tore the edge.	severthes
24. The hippie changed his appearance. He cut his hair.	puffix

Appendix C-2: Filler stimuli block 2 (randomized presentation)

Passage	Probe: nonsense word
25. The porter delivered the luggage. He received two bucks.	fulnest
26. The ranger loved wildlife. He enjoyed his job thoroughly.	aircess
27. The knight watched the crowd. He identified the imposter.	hasits
28. The coach changed the line-up. He replaced the striker.	scationsism
29. The tycoon attended the opening. He named the factory.	commity
30. The novelist changed the setting. He continued the chapter.	exhing
31. The waiter ran down the list. He suggested salmon.	brider
32. The shooter saw the target. He held his breath.	contruss
33. The boss mailed the invoice. She kept a record.	confissify
34. The tailor bought some fur. He made a coat.	flaste
35. The nurse hated the alarm. She modified the sound.	tomper
36. The waitress scanned the menu. She promoted the crayfish.	combinsons
37. The bully met his match. He lost the fight.	minuous
38. The medic stocked the supplies. He counted the bandages.	atinful
39. The surgeon opened the wound. He removed the bullet.	aerousion
40. The amateur wanted to win. She checked the score.	problity
41. The mother prepared lunch. She boiled the thick noodles.	mastry
42. The designer saw the chair. She liked the leather.	coffets
43. The umpire changed his mind. He retracted the penalty.	siloss
44. The wrestler needed a break. He got the tag.	daless
45. The toymaker carved the wood. He made a doll.	repounty
46. The runner ignored the pain. She pictured the finish-line.	rushifying
47. The electrician found the problem. The cable was faulty.	snords
48. The bartender was forgetful. He made the wrong cocktail.	perfeii